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14. ABSTRACT
The Small-unit Training for Adaptability and Resilience in Decision-Making (STAR-DM) effort had three primary goals: (1) develop and validate a generalizable training framework to better train adaptable, stress-resilient small unit leader decision makers in simulation environments, (2) implement the framework into Marine Corps-specific simulation-based Squad Leader Training Packages (SLTPs) and validate their training effectiveness, and (3) integrate solutions into assessment and debrief tools to make the training easily accessible to instructors. There were three key iterative areas of focus; field research, theoretical research and empirical research. As a result of the effort, four SLTPs focused on Squad Leader decision-making were developed. Based on experimental findings, the SLTPs were shown to induce a significant physiological stress response, and the framework, which includes process-level feedback and biofeedback, led to improved decision-making performance during training, a reduced stress response in trainees and showed promise for increasing overall mission performance. Results also suggest that performance improvements resulting from the training transfer to the field, leading to improved decision-making performance in stressful field exercises.

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Small-unit Training for Adaptability and Resilience in Decision Making (STAR-DM)

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Executive Summary

Over the past decade, the United States Marine Corps (USMC) has shifted its training focus towards enabling effective and efficient decision-making (DM) in its small unit leaders. Small unit leaders are increasingly required to make decisions with both tactical and strategic impact in the heat of the battle. Simulation-based training provides an opportunity for trainees to consolidate DM skills learned in the classroom and practice making decisions in stressful environments prior to entering resource-intensive live exercises. No collective and consolidated guidance, however, is available on how to utilize simulation to train small unit leader DM under stress. Guidance is needed in several key areas, including: 1) merging standards-based training with DM-based training, 2) inducing stress at levels that impact the decision process and force coping strategies, 3) integrating objective and quantitative assessments to understand performance deficiencies and 4) incorporating learning strategies that can enhance DM skills and increase resilience to stress.

The Small-unit Training for Adaptability and Resilience in Decision-Making (STAR-DM) effort described herein addresses these needs by developing a simulation-based training approach which outlines methods for scenario design, stress induction, assessment, and learning strategy integration. There were three main goals of STAR-DM:
1. Develop and validate a generalizable training framework (including the overall model, measures, and learning strategies) to better train adaptable, stress-resilient small unit leader decision makers in simulation environments,
2. Implement the training framework into Marine Corps-specific simulation-based Squad Leader Training Packages (SLTPs) and validate their training effectiveness, and
3. Integrate solutions into STAR-DM assessment and debrief tools to make the training framework and SLTPs easily accessible to instructors.

In order to develop the training framework, there were three key iterative areas of focus; field research, theoretical research and empirical research. The field research focused on understanding the types of stressful decisions that Squad Leaders typically face as well as identifying gaps in current training approaches. This research revealed user needs for training DM under stress, as well as the content for a library of stressful decision events faced in theater, which provided a basis for simulation decision events. Theoretical research was conducted to understand the state of the science on DM under stress, resilience, measures, and learning strategies, and an overall conceptual model for training DM under stress. This research resulted in the development of a training framework and hypotheses for measures of both DM and stress, ways to induce stress, and learning strategies to improve both DM skills and ability to cope with stress. Empirical research then looked to validate the training framework and inform the design of the simulation training packages and assessment and debrief tools.

As a result of the empirical research, four SLTPs were designed and developed and vetted at the Infantry Small Unit Leader Course. The packages are Virtual Battlespace 2 (VBS2)-based packages focused on Squad Leader decision-making, and are designed to be turnkey, high-throughput exercises. They are designed for a network setting in which a full USMC squad can perform a squad level mission. Each package contains four VBS2 scenarios with a running narrative and take approximately a half to a full day to complete. Each SLTP exposes the trainees to 20 discrete decision events and has an integrated pre-brief, assessment, and paper-based debrief tools along with intelligent enemies minimizing the need for instructor intervention. A tablet-based software tool for after action review was also designed and developed to support instructors in real-time assessment of performance during the SLTPs.

Based on experimental findings, the STAR-DM framework and SLTPs were shown to induce a significant physiological stress response, even in experienced Marines. The training framework, which includes process-level feedback and biofeedback, led to improved decision-making performance during training, a reduced stress response in trainees and showed promise for increasing overall mission performance. Results also suggest, but due to low experimental sample size do not definitely prove, that the performance improvements resulting from the use of STAR-DM transfer to the field, leading to improved decision-making performance in stressful field exercises. Future research is still needed in terms of a training effectiveness evaluation in order to fully evaluate the training effectiveness and field transfer of the complete STAR-DM training framework.

1.0 Introduction

Over the past decade, the United States Marine Corps (USMC) has shifted its training focus towards enabling effective and efficient decision-making (DM) in its small unit leaders. Small unit leaders with relatively little experience are increasingly required to make tactical decisions with critical second and third order effects. These near strategic level decisions are not being made in a Command Operations Center (COC), but in the heat of the battle, where the decision maker is surrounded by high levels of physical and emotional stress. Key to the development of effective decision makers is training, which effectively targets decision-making skills. The USMC has recognized this and made it a priority. In the 2012 Marine Corps Science and Technology (S&T) Strategic Plan, a key Training and Education (T&E) Science and Technology Objective (STO) is focused specifically on Warrior decision-making (STO 1), calling for the development of products and technologies to assist Marines at all levels in better preparing to make effective decisions in complex environments. Additionally, T&E STO 2 focuses specifically on small unit learning and performance assessment, requesting evaluation technologies and methodologies and scenario-based measures to enhance feedback and after action review (AAR). Further, studies have shown significant adverse effects of combat stressors on cognitive performance (Lieberman et al., 2005) as well as persistent changes in brain functional connectivity (Van Wingen et al., 2012). In fact, the 2012 Marine Corps S&T Strategic Plan also includes T&E STO 3 for Warrior Resilience and Med STO-9 for Stress resistance, resilience, and recovery, calling for products and technologies that enhance the understanding of and the training for resilience to stress. T&E STO 4 also calls for experiential learning technologies and methodologies that increase the capacity and quality of training due to the limited time and resources available for training. To ensure military success, and the health and wellness of our veterans, it is critical that small unit leaders receive efficient and effective training necessary to develop strategies which enable them to make effective decisions under stress and mitigate long term physiological and psychological impacts of stress.

The USMC 36th Commandant's Planning Guidance (2015) calls for a focus on better leveraging simulation training, especially capabilities that support the development of resilient leaders and sound tactical and ethical decision-making at the small unit level. It states:

> "Our investment in training systems will reflect the priority we place on preparing for combat and be fully integrated with training and readiness standards. I expect all elements of the MAGTF (Marine Air-Ground Task Force) to make extensive use of simulators where appropriate. My intent is for Marines to encounter their initial tactical and ethical dilemmas in a simulated battlefield vice actual combat." (p. 11).

Simulation-based training provides an opportunity for trainees to consolidate DM skills learned in the classroom (Cohn et al., 2007) and to practice making decisions in stressful environments (Cannon, Bowers and Salas, 1998) prior to entering resource-intensive live exercises. Simulation-based training also provides the opportunity to expose trainees to a large array of situations, environments and decision points not possible in live exercises due to logistical and resource constraints. Such experience supports building up a trainee's experience base – a necessity in moving an individual from a novice, analytic decision-maker to a more expert, recognition-based decision-maker (Marine Corps Institute, 2010). No collective and consolidated guidance, however, is available on how to utilize simulation to train small unit leader decision-making under stress. Guidance is needed in several key areas to ensure effective simulation based training, including: 1) merging standards-based training (e.g., Training and Readiness (T&R) standards) with decision-making-based training, 2) inducing stress at levels that impact the decision process and force coping strategies, 3) integrating objective and quantitative assessment to understand performance deficiencies and 4) incorporation of learning strategies that can enhance decision-making skills and increase resilience to stress (USMC, 2012).

The Small-unit Training for Adaptability and Resilience in Decision Making (STAR-DM) effort described herein addresses these needs by developing a simulation based training approach which outlines methods for scenario design, stress induction, assessment, and learning strategy integration. There were three main goals of STAR-DM:

1. Develop and validate a generalizable STAR-DM training framework (including the overall model, measures, and learning strategies) to better train adaptable, stress-resilient small unit leader decision makers in simulation environments,
2. Implement the training framework into Marine Corps-specific simulation-based Squad Leader Training Packages (SLTPs) and validate their training effectiveness, and
3. Integrate solutions into STAR-DM assessment and debrief tools to make the training framework and SLTPs easily accessible to instructors.

Table 1 below provides a summary of current approaches and how STAR-DM improves upon those approaches.

Table 1. Current Training vs. STAR-DM Approach

	How is it done today? Limitations of current practice?	What's new in the STAR-DM approach? Why will it succeed?
Training Framework **Model, Metrics, Learning Strategies**	• Stress/DM targeted separately; Interdependence not considered. • Metrics at outcome level; not granular enough to identify root cause. • No guidance for learning strategies to target decision making under stress.	• <u>Unified</u> DM under stress model, measures and training techniques. • <u>Objective, quantitative, granular,</u> metrics (behavioral, physiological) to tailor training. • <u>Integrated, tailored</u> learning strategies to bolster resilience of DM process.
Simulation Training	• Unstructured scenarios focused on T&R events lack ability to effectively train decision making. • Consumes valuable training time with limited exposure to decision experiences.	• <u>Merges</u> standards-based with DM training via scenarios designed to elicit adaptive DM skills. • <u>Leverages</u> the power of simulation to quickly build novice decision maker's experience base.
Assessment and Debrief Tools	• Assessment subjective, outcome level; limited by instructor recall and workload. • Debrief based on notes/salient memories; at times imprecise and incomplete.	• Objective assessment tools <u>free up instructor cognitive resources</u> to monitor performance. • Debrief tools provide snapshot of where/why breakdowns occurred so debrief can be <u>tailored to specific breakdowns</u> in need of remediation.

2.0 Technical Approach

The technical approach for STAR-DM followed an iterative design and development approach as indicated in Figure 1. The first step focused on identification of domain requirements, wherein the team worked closely with USMC Infantry Small Unit Leader Course (ISULC) instructors to understand small unit leader decision-making and the impact of stress on those decisions. Next, theoretical research was conducted to identify the state of the science in effective DM training and assessment. An initial training framework was developed, and a series of empirical research evaluations, laboratory studies, and a field study with Marines were conducted to validate the framework and fill theoretical gaps. The results of these studies drove the development of requirements for the framework design, as well as design of the simulation training packages and assessment and debrief tools. The effort was supposed to end with a culminating training effectiveness evaluation to assess the impact of the STAR-DM training framework and tools. Unfortunately, as will be discussed later, that experiment did not take place. The following sections will discuss, in more detail, each of the steps of the technical approach.
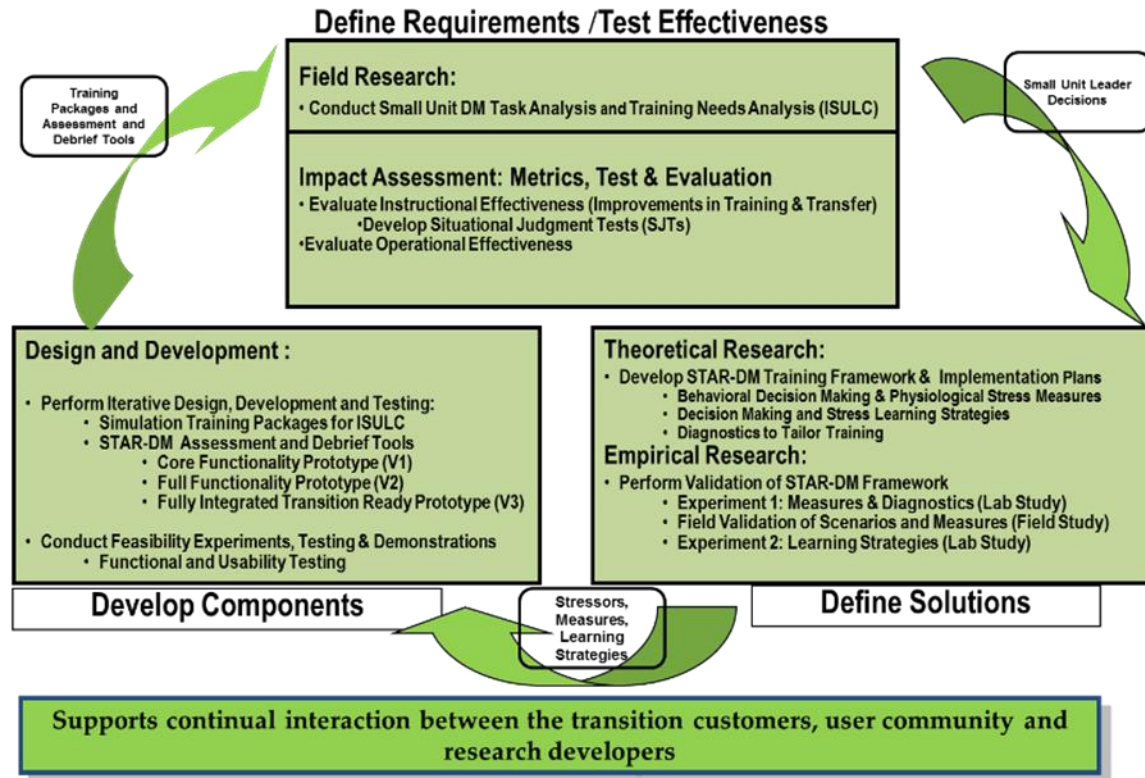
Figure 1. STAR-DM Technical Approach

2.1 Field Research Overview

In order to determine how best to fill training gaps in small unit leader decision-making under stress, it was first necessary to understand the current training given to small unit leaders in the Marine Corps. Therefore, the first step of the technical approach was to conduct field research in the form of a task analysis of small unit decision-making at the USMC ISULC at the School of Infantry East (SOI-E). The research team was looking to define the type of stressful decisions that small unit leaders need to make and how they are trained to make them. While at ISULC SOI-E, the research team also conducted a training needs analysis to identify training gaps that could be addressed with the simulation training framework being developed.

The ISULC, developed by the United States Marine Corps, is a six week course directed specifically at Infantry Sergeants with Squad Leader experience. The goal of the course is to develop leadership and DM capabilities by exercising critical thinking, supporting cognitive development and challenging a leader's ability to solve problems [USMC AITB (Advanced Infantry Training Battalion) New Course Brief, 2012]. Whereas traditional Programs of Instruction (POIs) focus on specific technical and tactical skills, the purpose of ISULC is to propel experienced Sergeants (E-5 with Squad Leader experience) to high decision-making expertise levels by creating opportunities for the trainees to leverage and add to their previously gained experience and technical and tactical knowledge to more effectively assess situations and make decisions. Thus, ISULC is a POI focused on application – specifically to develop expert decision makers who can excel at leading small units in combat. To achieve this end, numerous training techniques and materials are employed, including traditional classroom lecture, computer-based simulation, and live training. All ISULC training is rooted in T&R Manual tasks with a heavy focus on guided discussions, decision forcing cases, tactical decision games (TDGs), sand-table exercises (STEXs), and simulation-based training (USMC, 2011). This garrison training feeds into several field exercises and live-fire training ranges where the Sergeants rotate through a variety of billets from Platoon Commander to Squad Leader, providing them the opportunity to make a variety of decisions across a large range of situations.

In order to identify critical small unit leader decisions to include in the STAR-DM training framework, specific decision points were extracted from a variety of ISULC training events (e.g. classroom training, STEXs, field exercises), which were observed by the research team. Furthermore, the research team sat down with seven Marines, with a variety of Squad Leader experience, to extract decisions they faced in theater under stress. This comprehensive list of relevant small-unit leader decisions was then categorized into a library of decisions to be used in the development of the training scenarios (Appendix B).

2.2 Theoretical Research Overview

The STAR-DM effort sought to develop a training methodology that is not only operationally relevant, but also theoretically sound. Therefore, in parallel to the field research conducted at ISULC SOI-E, the research team also reviewed the literature for models, measures, and training techniques related to decision-making, stress, resilience, and adaptability (see Hannigan et al., 2012, for details). Models of the DM process were reviewed, and the OODA loop (Observe, Orient, Decide, Act; Boyd, 1987) was chosen as the model to base the STAR-DM effort off of due to its general acceptance in the military. The effects of stress on decision-making were then reviewed, specifically on each step of the OODA loop, as well as on the overall process. The literature review also sought to identify measures of both DM and stress and ways to induce stress to include in the empirical research portion of the STAR-DM effort. Finally, the review sought to identify learning strategies to improve both DM and an individual's ability to recognize stress overload and cope with it, enabling the individual to focus on sound decision-making.

2.3 Empirical Research Overview

Once the theoretical gaps were defined, the next step in the technical approach was for the STAR-DM research team to design four experiments with the aim of addressing the gaps in the theory. Experiment 1, the first lab experiment, was designed to address three questions:
- Can simulation scenarios induce stress, and if so, how does it compare to the gold standard socio-evaluative stressor?
- Which physiological measures are most indicative of stress and resilience?
- Which DM measures are most discriminative/predictive?

The findings from Experiment 1 were that stress can be induced, measured, and it does have an impact on DM skills. Given this information, Experiment 2 (i.e. second lab experiment) was designed to address one additional question:
- Can learning strategies (i.e. process level feedback and biofeedback) effectively improve decision-making under stress in infantry-based simulation scenarios?

The outcome of Experiment 2 indicated that DM learning strategies and process level feedback improve DM performance and stress strategies and biofeedback reduce the stress response. Furthermore, both process-level feedback and biofeedback showed promise for increasing overall mission performance.

While Experiments 1 and 2 focused on the general population, the Field Study and the planned, but not executed, training effectiveness evaluation (TEE) focused on the target population of Marine small unit leaders. The field study was designed to determine if the effects of the Experiment 1 would translate to the Marine population. The TEE was designed to investigate if the learning strategies from Experiment 2 would demonstrate the same effects on the target Marine population and whether the training efficacy of the full STAR-DM training framework would transfer to the field. The outcome from the field experiment showed that a stress response can be induced in Marines using simulation-based training and that the training can improve DM performance. Additionally, the improved performance appears to transfer to the field, though due to low sample size further study is needed. The TEE was not executed, therefore the effect of learning strategies on Marines and training transfer of the complete STAR-DM package was not able to be assessed. More details about all four studies including the methods and results are found in Section 3.3.

2.4 Simulation Squad Leader Training Packages (SLTP) Overview

One of the steps of the technical approach was to design four simulation packages based on the findings from the field, theoretical, and empirical research. The packages were designed for ISULC SOI-E (SLTPs 1 & 2) and for the Combating Terrorism Technical Support Office (CTTSO) (SLTPs 3 & 4). SLTPs 1 & 2 were initially created to support data collection in the field study and were refined based on the results from the field study and Experiment 2.

The packages are Virtual Battlespace 2 (VBS2)-based packages focused on Squad Leader DM, and are designed to be turnkey, high-throughput exercises. The packages are designed for a network setting in which a full USMC squad can perform a squad level mission. Each package contains four VBS2 scenarios with a running narrative and take approximately a half to a full day to complete. Each package exposes the trainees to 20 discrete decision events and has an integrated pre-brief, assessment, and debrief tools along with intelligent enemies to minimize the requirement for instructor intervention.

The training packages are comprised of the following components:

1. Multimedia Videos: VBS2-based Road to War and Operational Update videos detail the situation and environment and are designed to engage and motivate the trainees.

2. Mission Orders/ Fragmentary Orders (FRAGOs): Paper-based and/or video-based mission orders/FRAGOs are included for delivery by the instructor/facilitator for viewing by the trainees. After receiving mission orders, the packages are designed to allow the Squad Leader to plan the mission and task fire teams based on these orders. There are guidelines provided to make this a more stressful experience, such as time pressure and instructor maintaining eye contact and providing pointed feedback.

3. VBS2 Scenarios: Each package contains four VBS2 scenarios designed to allow the entire squad to execute the Squad Leader's plan in a networked VBS2 simulation. As the team performs the scenario, they encounter five discrete decision events in which the Squad Leader has to determine the best course of action and/or adapt his plan.

4. Measurement and Debrief Tools: The packages have integrated paper-based assessment tools that allow instructors to assess performance at the process level. The assessment tools are designed to also facilitate a DM-focused debrief.

5. Instructor Preparation Guides (IPGs): Each package is accompanied by an IPG, which walks an instructor step-by-step through delivery of the training packages and contains supporting materials such as maps, orders, and performance/debrief checklists.

Additional details about the SLTPs can be found in Section 4.

2.5 Assessment and Debrief Tool Overview

The assessment and debrief tool was developed to address the training gap in which instructors required objective measures by which to assess a Squad Leader's decision-making. The first version of the tool was a paper-based instructor checklist with a breakdown of all the Squad Leader's expected OODA items per event, both good and bad. The OODA items were ranked from best to worst, and space was left for any alternative OODA items chosen by the Squad Leader that were not present on the form. The checklist is arranged in such a way that the instructor can easily collect and scan information about the Squad Leader's DM process, and use the form to facilitate a process-level debrief regarding the strengths and weaknesses of the Squad Leader's decision-making. The paper-based assessment checklists were used in the field study by Marine instructors and refined based on their feedback. The strong upside to this version is that it requires no extra technology to implement. The downside is that the instructor is either tasked with, or unable to keep track of, minute simulation details such as the event number or the number of times the squad is hit by enemy fire.

The second version of the assessment checklist is a software tool that has the event checklist programmed in, is connected with the VBS simulation to monitor simulation details such as the event number and a variety of performance-based metrics, and has a checklist editor so that the instructor can make edits or create new checklist assessments. The software version of the Assessment and Debrief tool is designed to allow the instructor to focus on the Squad Leader's DM process and reference metrics when appropriate to facilitate the Squad Leader's training. The downside is that the software version requires an additional computer or tablet. The computer can weigh the instructor down from moving about the classroom to facilitate situational awareness of the events in the simulation. The use of a tablet solves this issue, but faces the hurdles of needing wireless connectivity that is difficult to get approved for use in the Marine Corp because of security concerns. Details regarding the assessment and debrief can be found in Section 5.

2.6 Final Training Effectiveness Evaluation (TEE) Overview

In order to determine if the potential gains demonstrated in the laboratory and field studies would transfer to the real world environment, a training effectiveness evaluation, or TEE, was designed. This experiment had the additional goals of evaluating the effectiveness and return on training investment of other training environments. The primary research question for the study was: How does the training effectiveness of the following training environments compare: Classroom training (in the form of TDGs), Simulation training (STAR-DM SLTPs), training on a basic non-instrumented range (such as 62 Area RUF at Camp Pendleton), training on a more-sophisticated, instrumented range (such as Kilo2 at Camp Pendleton), and training at Camp Pendleton's Infantry Immersion Trainer (IIT).Though a plan for the study was created and significant effort was expended in an attempt to secure a unit to participate in the testing, the team and program sponsors were unable to find the necessary available participants to execute the study. An overview of the planned TEE is discussed in Section 3.3.4.

3.0 STAR-DM Training Framework

The overall objective of the STAR-DM framework is to provide operationally relevant guidance that is based on a strong foundation of theoretical and empirical research on how to train infantry small unit leaders to make effective decisions under stress. The framework includes not only the overall methodology, but also tools in the form of the SLTPs, which include an overall process that induces stress, simulation scenarios that provide specific opportunities for small unit leaders to practice decision-making, and associated assessment tools and directions for instructors. The SLTPs are meant to be turnkey training packages that provide 1-2 days of training with little preparation needed from the instructors.

In order to develop the training framework, there were three key iterative areas of focus; field research, theoretical research and empirical research. The field research focused on understanding the types of stressful decision events that Squad Leaders typically face as well as identifying gaps in current training approaches. Theoretical research was conducted to understand state of the science from the research reviewed on decision-making under stress, resilience, measures, and learning strategies, an overall conceptual model for training decision-making under stress. Empirical research then looked to validate the training framework and inform the design of the simulation training packages and assessment and debrief tools. More details on the work conducted in each of these areas in presented in the following sections.

3.1 Field Research: Understanding Small Unit Decision Making Under Stress

The field research was conducted at ISULC SOI-E. It consisted of two primary parts; a task analysis to understand the types of decisions a Squad Leader would typically encounter and a training needs analysis to understand gaps in current decision-making training.

3.1.1 Task Analysis

Goal

The main goal was to identify types of decision events that Squad Leaders are often presented with in order to create a library from which decisions could be selected to embed in VBS2 scenarios. This was achieved through two means. First, portions of the course were observed to extract decisions events used in practical application exercises as well as those presented anecdotally to trainees by instructors. Second, stressful decisions experienced by Small Unit leaders when deployed in theater and acting as Squad Leaders were extracted through subject matter expert (SME) interviews. A secondary goal was to extract additional information to better understand how the decisions were made and how to assess them. Thus, information regarding decision considerations, prerequisite knowledge needed, situation assessment, and decision outcomes was sought.

Methods

Two primary data collections methods were utilized to extract decisions and associated considerations; course observation and interviews. Course observations were conducted at ISULC during the organic weapons portion of the course. Thirteen Squad Leaders participated in this instantiation of the ISULC. Two researchers attended both morning and afternoon portions of the class over the observation period. Over that time period, instruction included instructor-led lecture using PowerPoint slides, demonstration of equipment, and practice in writing tasking orders and mission plans using sand table exercises.

During the sand table exercises, researchers observed and recorded the types of decisions and the considerations informing those decisions. These were extracted from discussion following the trainees' briefs, and discussion between the instructor and the group of trainees in which the instructor would ask if they considered aspects of the situation or what they would do if certain events occurred. Stress factors were also extracted from these discussions.

Researchers also interviewed nine Marines with Squad Leader experience. However, two of interviewees were unable to provide the sought after information because of limited experience as Squad Leaders in theater. Therefore, data collected from seven interviews provided relevant decision events presented herein. The seven interviewees ranged in age from 24-39 (average of 31) years and ranged in rank from Lance Corporal to Gunnery Sergeant. Their average number of deployments was five and average time as a Squad Leader was approximately two years, not including the Gunnery Sergeant who had been a Squad Leader for only three months before acting as a platoon sergeant for eight years. Each interview lasted approximately one hour and followed the following format:

1. Each interviewee was instructed on the purpose of the interview and the potential benefits that would come from the interviews.
2. Demographic data was collected including age, rank, military occupational specialty, number of deployments, location of deployments, and amount of time spent as a Squad Leader.
3. The SMEs were then asked to describe situations where they had to make difficult and stressful decisions as a Squad Leader, including how they decided what to do and what were alternative courses of action. They were told that the researchers would not be judging the decisions made in any way, and that they were merely trying to collect data on operationally relevant situations in which stressful decisions were made.
4. The interviewees then described decisions made in theater when acting as a Squad Leader that were stressful, where several decision alternatives existed, and where they may or may not have selected the most optimal course of action.
5. The researcher then asked the interviewee a series of amplifying questions regarding the decision.

Results

The methods resulted in the identification of 37 decision events (see Appendix B) and associated information to include the following:

a) Background information: General situation, task/mission objective and decision descriptions.

b) Prerequisite knowledge: Intelligence, Commander's intent, previous experience in the area, enemy tactics, techniques, and procedures (TTPs), etc. that factored into the decision.
c) Data collection: Multimodal cues observed which impacted the decision.
d) Situation assessment: Situational factors and understanding of the situation based on a combination of the prerequisite knowledge and cues observed.
e) Courses of action: Alternative courses of action identified by the decision-maker as options based on the situation assessment.
f) Action taken: Course of action taken by the decision-maker.
g) Decision outcome: Outcome of the decision based on the action taken by the decision-maker, as well as potential outcomes of alternative courses of actions.
h) Stress factors: Environmental and task factors that made the decision more stressful for the decision-maker.

These decision events were then categorized in an attempt to roll the events up into higher level decision areas. The events fell into five primary decision area categories:

1. Act autonomously versus act with support
2. How to move in danger area
3. Shoot/no shoot
4. Abort mission versus continue
5. Type of method to employ to achieve mission objective

3.1.2 Training Needs Analysis

Instruction at ISULC SOI-E occurs via a combination of lecture, guided discussion, TDGs, STEXs, simulation, and field exercises. It was determined that the ISULC would benefit from a number of developmental enhancements in each of the observed sections [sim, live-fire, finish of exercise (FINEX)] across the areas of training objectives, training content, performance measurement, and interventions. Table 2 highlights how each of these areas can be improved upon. These recommendations guided the development of the SLTPs and were presented to ISULC as opportunities to enhance the training effectiveness of the ISULC curriculum.

Table 2: Opportunities for Increasing Effectiveness of Decision Making Assessment and Training

	Opportunities
Training Objectives	The benefits of VBS2 can be better utilized by focusing the training on the execution of missions in addition to mission planning. Simulation facilitates the insertion of a large array of scenario cues to which the trainee must observe, orient, decide and act. This provides the flexibility to expose the trainees to a large number of varying environments and situations. Specific training objectives can be attained through the use of VBS2 by carefully structuring scenarios with the inclusion of multimodal cues designed to elicit and test decision making processes at varying difficulty levels. Additionally, scenarios can be built to provide positive or negative reinforcement to actions taken by the unit by allowing them to see the consequences of their decisions play out. **Recommendations:** • Focus training on decision making during both the planning of missions as well as execution to provide trainees the opportunity to see the pros and cons of their plan as it plays out and make dynamic decisions necessary to adapt their plan to the changing situation. • Utilize VBS2 scenarios systematically structured via integration of training objective-based scenario decision events designed to elicit adaptive decision making skills.
Training Content	ISULC covers numerous decision areas throughout the course. Simulation and live training exercises can be used to consolidate the skills learned during the other ISULC training modules. To achieve this, it is necessary to identify ISULC target decision area training objectives and design simulation and live training exercises to allow trainees to gain experience making these types of decisions in realistic environments that provide powerful feedback as the effects of the decisions play out. Further, designing the scenarios such that they take less time to plan and execute, more trainees would have the opportunity to act as the squad leader and gain experience making decisions. **Recommendations:** • Identify ISULC target decision areas and create Master Scenario Event Lists (MSELS) for all simulation and live training exercises that map scenario events to these decision areas. • Reduce length of scenarios to allow a greater number of missions executed per day.

Performance Measurement	Current performance measures utilized in simulation and live exercises are both subjective and at the outcome level. This provides limited diagnostics to facilitate targeting feedback to the root cause of performance deficiencies (for instance, was the problem that the squad leader wasn't utilizing the right information or did he not select a good decision alternative?). Instructors need tools that are easy to use and allow them to objectively assess decision making at the process level. The Decision Making Assessment Tool (DMAT) is a good starting point, but the mixed reactions of the instructors, their reports of areas for improvement, and their general lack of complete satisfaction with the DMAT indicate room for refinement. There is a clear need for reliable, valid assessment measures that can be used to more comprehensively evaluate each student.
	
	Recommendations:
	
	• Simulation: Utilize VBS2 system-collected measures to capture objective, process level decision making performance measures.
	• Live: Utilize a combination of event-based performance checklists to capture objective, process level decision making performance measures in hand with pre/post-test measures such as Situational Judgment Tests (SJTs).
	   - Systematically gather feedback from ISULC instructors regarding the DMAT and refine and validate improved assessment tool.
	   - Identify, develop, and field test additional decision making assessment measures such as SJTs.

Interventions	Within the current format of the simulation portion of the ISULC, there is a significant amount of time for the instructors to provide feedback and other training interventions. While peer-to-peer and instructor feedback on the outcome is important, interventions could be more robust and targeted. For instance, maintaining or building an alignment between the current training and what students already know as with Advance Organizers, or critically examining a mission brief and the anticipated mission during crystal ball exercises or pre-mortem exercises can help build Marines' decision-making skills. What is needed are pre, during and post training techniques and tools which allow trainees to become fully immersed in the training, practice dynamic decision making skills and receive real-time and after action feedback targeted to their specific skill deficiencies. **Recommendation:** • Incorporate into simulation training pre, during, and post training interventions which have been shown to enhance decision-making skills and are easy for instructors to deliver.

Based on observation and later confirmed by the AITB ISULC website, the class is approximately 75% practical application and 25% classroom instruction. These practical application exercises, especially the computer-based simulation exercises, provide a prime opportunity for utilization of the STAR-DM training framework presented above as they provide an opportunity for:
      1) Instantiation of stressors and numerous environmental variations,
      2) Measurement of trainee performance and stress response, and
      3) Incorporation of learning strategies such as metacognitive feedback and biofeedback methods.

In addition to the above opportunities and recommendations, there are three key limitations or gaps in the computer-based simulation exercises which the STAR-DM framework can also help address, First, the simulation exercises lack a deliberate approach to scenario design that targets the DM process and allows for the trainees to hone underlying decision skills (e.g., OODA). Further, during the observed computer simulation-based training there was a lack of emphasis on specific decision themes (commander's intent, METT-TC (Mission, Enemy, Terrain & Weather, Troops, Time Available, and Civilian Considerations) analysis, Terrain Analysis, Battlespace Geometry, etc.) that were a focus during the TDGs and guided discussions conducted during the first weeks of the ISULC course. Scenarios are needed which allow the trainees to consolidate the decision skills learned in the classroom and develop skills and coping strategies to a level that is resilient to stress.

A second limitation consistently observed throughout all practical applications is the lack of instantiated metrics with which to assess the DM process of the Sergeants. In order to effectively train stress resilient decision skills, it is necessary to measure the decision process as well as stress response. Without these measures in place, it is not possible to tailor the training to the decrements of the trainees and facilitate the development of decision skills, and stress appraisal and coping skills required to make decisions under stress.

Finally, decision-focused learning strategies are utilized throughout the course. However, they did not focus on building resilience to stress.

STAR-DM developed Instructor Preparation Guides (IPGs) with guidance aimed at addressing the above mentioned gaps and improving the ISULC ability to target small unit DM under stress. These IPGs integrate decision targeted scenarios with metrics and learning strategies aimed to build stress resilient DM skills. The scenarios and IPGs are further discussed in Section 4.

3.2 Theoretical Research and STAR-DM Conceptual Model

Theoretical research was conducted in three primary areas; decision-making and stress, resilience to stress and learning strategies. Information gleaned from the state of the science review of those areas informed the STAR-DM conceptual model which formed the basis for the STAR-DM training approach

and SLTP development. The following sections provide a summary of the research performed and the conceptual model.

3.2.1 Decision Making and Stress

In order to elucidate the effects of stress on DM, it was first necessary to define the DM process. Many models of decision-making detail a four step process. Models such as the OODA Loop (Observe, Orient, Decide, Act; Boyd, 1987), the SHOR model (Stimulus, Hypothesis, Options, Response; Wohl, 1981), and the CASE model (Collect data, Assess situation, Select response, Evaluate response; Johnston et al., 1998), decompose the DM process into these core processes: 1) collection and integration of sensory information, 2) interpretation of this sensory information to determine the current environment and situation, 3) evaluation of alternative courses of actions and response selection, and 4) planning and execution of the response. For the STAR-DM effort, the OODA Loop (Figure 2) was chosen as the DM model of focus because it has traditionally been used by military commanders as a descriptive framework of the military DM process and therefore provides operational relevance to the conceptual model.
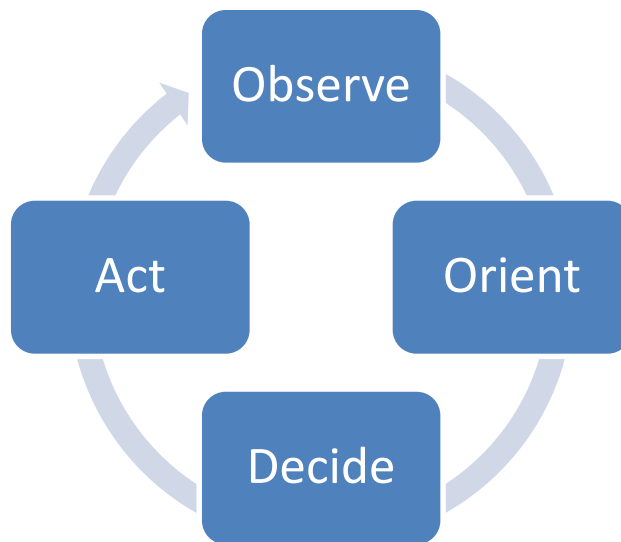

Figure 2. OODA Loop (Boyd, 1987)

Stress can be described as occurring when a person appraises an environment as taxing or exceeding available resources and endangering personal well-being (Lazarus and Folkman, 1984). According to Stokes and Kite (2001) stress may be viewed as "…an agent, circumstance, situation that disturbs the 'normal' functioning of the individual… stress is seen as an effect – that is the disturbed state itself … this difference in meaning is arguably the most fundamental source of the confusion surrounding the stress concept." (p. 109). In their review, Stokes and Kite (2001) asserted that there are two traditional models of psychological stress: a stimulus-based and a response-based. The stimulus-based stress model assumes that certain conditions cause stress and labels these conditions stressors. For example, any dismounted patrol in an unfamiliar area can be a stressor if one appraises it as taxing. Other examples of stressors may include heat and cold, time pressure, etc. The authors argued that the stimulus-based approach is inadequate to explain stress and the human response because it does not explain individual differences, ignores emotion, and does not evaluate circumstances (Staal, 2004). The response-based stress approach proposed that stress is defined by the pattern of responses (i.e., physiological, cognitive, and affective) that are caused by a given stressor. This approach focuses on the individual's reaction instead of the mechanical nature of stress and response (the stimulus-based model) of a given stressor. A third model of stress called the transactional model takes a different look at stress. Instead of viewing stress as a stimulus or an individual response, it focuses on the interaction between the environment and the individual (Stokes and Kite, 2001). It emphasizes the role of the individual's appraisal of situations in shaping their responses. This model is an important piece in the present work associated with small unit DM because it provides a foundation for developing training strategies to build individual resilience. By accounting for individual stress appraisal differences, training strategies can target individual users.

Stressors of various types (physical, psychological) can negatively influence the DM process, leading to physiological changes (e.g., increased cortisol, adrenaline, and serotonin) as well as cognitive changes, such as decreased cognitive capacity and reasoning (McNeil and Morgan, 2010).

These effects may be seen at individual stages in the DM process. The first stage of the DM process, observation/data collection, requires appropriate and timely attention allocation to task relevant cues. Stress such as time pressure, workload, and anxiety have been shown to lead to attentional narrowing by reducing cue utilization, shrinking the perceptive field, and reducing an individual's environmental scan (Staal, 2004). For instance, Entin and Serfaty (1990) found a reduction in the frequency and amount of information sought by decision makers under high-stress conditions. Further, stress creates distracting psychological (e.g., anxiety) and physiological (e.g., increased heart rate) responses, which can draw attention away from task relevant information (Baradell & Klein, 1993). Stress can also result in reversion of automated performance to conscious control, wherein attentional resources are consumed by step-by-step monitoring of task performance (Wickens & Hollands, 2000). The next two steps in the DM process, situation assessment and decision alternative evaluation, rely heavily on performers' working memory (Endsley, 1995). Stressors such as anxiety, noise, fatigue, extreme temperature and military combat significantly reduce working memory capacity and performance of working memory tasks, thereby limiting situation assessment (Staal, 2004). This reduced working memory capacity can also negatively impact the process of evaluating and selecting decision alternatives, leading to a reduction in the number and quality of alternatives considered (Staal, 2004). Keinan (1987,) among others, showed that participants under stress are affected by premature closure, in which "a decision is reached before all available alternatives have been considered." Additionally, those participants can also succumb to "nonsystematic scanning" in which a stressed decision maker frantically searches for a solution to the problem (Keinan, 1987). In a stress free environment, decision makers rely on a number of heuristics ranging from simple to complex (Gigerenzer and Selten, 2001) to select the best option to meet their goals. To determine the best approach, they search their memories for the criterion-linked probability information. According to Gigerenzer, Haffrage, and Kleinbolting (1991), this search for information is quick, streamlined, and tends to rely on the most valid probabilistic cue separating alternatives. When under stress, DM tends to become rigid with fewer alternatives scanned (Broder, 2003). In addition, research has shown that individuals may rely more on previous responses regardless of previous success with such responses (Lehner et al., 1997). Finally, the execution stage has also been shown to be influenced by stress. Decreased execution can come in many forms, such as increased errors and movement variability on perceptual-motor tracking tasks (van Galen & van Huygevoort, 2000) and increased errors in heading, steering, and reduced perceptual sensitivity on driving tasks (Matthews & Desmond, 2002).

In general, when people are under stress the DM process is impaired, leading to reductions in quality of and confidence in decisions. These findings have been demonstrated across a variety of domains ranging from firefighting (Ozel, 2001) to aviation (Wickens, Stokes, Barnett, & Hyman, 1991). Thus, the challenge is to train Warfighters to be resilient to stress by enabling the development of strategies to counter the physiological and psychological impacts of stress and maintain performance while completing missions under high stress conditions.

3.2.2 Resilience to Stress

Resilience reflects one's ability to maintain stable equilibrium when confronted with stress or endure when presented with significant challenges (Bonnano, 2004; Masten & Narayan, 2012). Upon exposure to stress, resilient individuals are able to maintain focus by appropriately appraising the stressor(s) and implementing both physiological and psychological coping strategies as necessary, allowing for effective DM skills regardless of stressor(s) present (Lazarus, 1966). Such individuals are able to avoid negative consequences of stress, and show minimal disturbance to performance – some individuals are even able to thrive under such conditions, showing greater self-confidence and skills (Epel et al., 1998). These individuals have been shown to exhibit strengths in stress appraisal (i.e., assessing best/worst/likely outcomes to put stress into perspective). Studies have shown that resilience can be improved through various methods, especially when interventions are early in skill development (Feder, Nestler, and Charney, 2009). For example, intermittent, acute stress exposure can have positive effects on physiology, allowing individuals to bounce-back and maintain tight allostasis (the process of maintaining a state of

homeostasis; Epel et al., 1998). Thus, training Warfighter resilience during DM training should focus on two main objectives 1) enhancing adaptability through stress appraisal skills and 2) developing physiological and psychological coping strategies that support recovery (i.e., bounce-back) and effective performance despite the experience of stress.

Experimental reports on this subject have focused on long-term trajectories (weeks to months) of resilience, with little or no focus on whether significant changes to resilience could be achieved by short-term interventions (Winslow et al., 2013). This effort proposed that the quantification of an individual's physiological and behavioral response to stress under controlled conditions is an indication of the individual's level of resilience, meaning that short-term interventions could lead to improvements in resilience. A goal of the training framework was to facilitate assessment of a trainee's resilience to stressors during DM performance in order to adapt training to push the trainee up the expertise continuum. In this model, it was proposed that adaptability is a component of a performer's resilience. Specifically, resilience can be modeled as a function of 1) the time needed to recognize that the environment has changed and the need to change action, which aligns with the initial performance drop resulting from a stressor – the adaptability phase and 2) the time to consider decision alternatives and act – the bounce-back phase. See Winslow et al. (2015) for a more detailed review of the resilience literature and Carroll et al. (2012) for a more detailed explanation of the model for training resilient decision-making.

3.2.3 Assessment of Decision Making Performance and Stress

Based on the theoretical research on resilience, initial efforts in determining the assessments to be utilized in the STAR-DM framework focused on measures of adaptability and bounce-back. Table 3 below describes some of the high-level measures for each of these constructs (for more details see Carroll et al., 2012).

Table 3. Measures of Adaptability and Bounce-back

Adaptability	Bounce-back
Recognition: Ability to recognize new threats/ opportunities and orient to them as if ample time to plan and prepare	Perspective: Ability to maintain focus and change thoughts/behaviors in a positive manner as needed to complete tasks despite presence of stress
Robustness: Ability to degrade gracefully under attack or as a result of partial failure	Recoverability: Ability to recover from decreased performance as a result of exposure to stressors
Stress Appraisal: Ability to accurately assess best case, worst case and most likely case as a result of stress exposure	Flexibility: Ability to maintain/regain effectiveness across a range of tasks, situations, and conditions
Allostatic Load: Ability to maintain balance physiologically in the presence of stress	Allostatic Load: Ability to maintain balance physiologically in the presence of stress
Agility: Ability to recognize when to shift from one strategy to another	

However, as more work was done on the design of the conceptual framework and implementation of the framework for training DM under stress, it was determined that measurement needed to be more detailed and should really focus on the two main components of the training – decision-making and stress (Carroll et al., 2013).

Decision-making Assessment
The framework for assessing DM performance is based on the four stages of the OODA loop (Boyd, 1987). Decomposition of the DM process into these four stages allows decision-making to be assessed at the process level in order to understand the root cause of decision breakdowns. In addition to typical decision outcome measures (e.g. decision effectiveness and time to decide), each stage of the decision process can be assessed independently. For the Observe stage, there are critical Areas Of Interest (AOIs) which should be attended to in order to effectively understand the situation. Measures for the Observe stage could include eye tracking measures such as percent of critical AOIs fixated on and

percent of critical AOIs fixated for greater than 300 ms (i.e., significant attention allocation, see Carroll, 2010), number of fixations, and average and total fixation duration on critical AOIs (for metric details, see Carroll, Kokini and Moss, 2013). However, during the testing of the SLTPs, these measures proved to be practically infeasible. Therefore, the Observe phase measures ended up being collected similarly to those for the Orient and Decide phases. These stages are much more challenging to assess as these are generally internal and unobservable processes. A combination of two techniques is used to assess these stages of the DM process. First, contextually relevant online queries (Klein & Hoffman, 1992), which in the military context can be instantiated as an information "pull" from higher command, are incorporated into the scenario in which decision makers are prompted to answer questions related to the events unfolding as they perform. Second, by crafting scenarios designed to elicit certain responses, inference-based measures (Gugerty, 2011) can be utilized to infer the Observe, Orient and Decide stages by monitoring communications and actions. For instance, in order to assess the Observe and Orient stages, at various points throughout the scenario the trainee is asked to verbally report what they see and what it means. Based on the percentage of critical situation factors reported, observation and orientation performance is assessed. In order to assess the Decide stage, the trainee is asked to verbally report the possible courses of action they can take. Based on the effectiveness of the courses of action reported and the actions taken, the effectiveness of the Decide stage is assessed. The Action phase is assessed based on how effectively the response is carried out. However, Action is not a major focus of this effort as it is typically an indication of tactical/technical skills, not decision effectiveness. These measures facilitate the assessment of each stage independently and provide granularity in assessment to understand where breakdowns in the DM process originated and to identify patterns of these breakdowns across decisions (e.g., does a trainee have issues with observation across multiple decisions that need to be remediated).

Stress Assessment

Stress can impair the DM process leading to reductions in quality of and confidence in decisions (for review of impacts of stress on decision-making see Carroll et al., 2012). Assessment of an individual's stress response during DM performance can help to determine if performance decrements are due to basic performance deficiencies or failure to be resilient to stress, and therefore provide insight into how to remediate performance decrements. Stress response can be objectively and quantitatively assessed, in near real time, without disruption to task performance by utilizing physiological measures. When an individual encounters a significant stressor, the body experiences hormone release and subsequent physiological effects on multiple organ systems, including heart rate increase, pupil dilation, blood vessel constriction, and activation of sweat glands. Physiological data representative of these changes, such as electrocardiogram (ECG), electromyogram (EMG), electrodermal activity (EDA), and pulse plethysmography (PPG) can be measured with sensors (Carroll et al., 2013). Measures include: 1) heart rate variability (HRV), 2) pulse transit time (PTT), which is the time it takes the pulse waveform to propagate from the heart to the periphery (i.e., the thumb), 3) respiratory sinus arrhythmia (RSA), which is a naturally occurring variation in heart rate that occurs during a breathing cycle, 4) EMG root mean square to capture neck and back tension, and 5) electrodermal response (EDR), spikes which occur 1 - 3 seconds following stimulation and are due to autonomic innervation. The goal was to identify the most robust physiological indicators of stress response in order to develop a classification method for identifying periods during training when an individual is experiencing significant levels of stress.

3.2.4 Learning Strategies

Individualized learning strategies can focus on building resilience into the DM process by focusing on 1) enhancing stress appraisal skills, particularly in early stages of the DM process, and 2) developing physiological and psychological coping strategies that support recovery (i.e., bounce-back) to effective performance levels. Therefore, similar to the initial review of assessment strategies, the initial review of learning strategies also focused on those pertaining to adaptability and bounce-back. A few of these are highlighted in Table 4 below (see Carroll et al., 2012 for more details).

Table 4. Learning Strategies for Adaptability and Bounce-back

Adaptability	Bounce-back
Metacognition Strategies: Guide reflective thought to identify best case, worst case, and most likely case that may result from stressor to put into perspective	Stress Inoculation Training: Conceptualization and education regarding stressors, skill acquisition and rehearsal under stress, and encouraging application of coping skills
Mindfulness Training: to increase attentional control and concentration under stress	Biofeedback: Provide physiological biofeedback to increase awareness of stress response and guide conscious evaluation and control over physiological state

However, the challenge is identifying the optimal strategies that are effective as well as feasible to implement in a military schoolhouse setting. Therefore, this set of learning strategies was refined based on operational constraints while expanding it to include learning strategies that also target the decision-making process. These strategies are presented in Table 5 (from Carroll et al., 2013) along with the associated training phase (i.e., pre, during, post).

Table 5. Summary of Learning Strategies

Target Construct		
Decision-making	**Stress Response**	**Adaptability**
Pre Training Planning Exercises Crystal Ball Exercises Premortem Exercises Advanced Organizers During Training Event-based Training Post Training Error-based Feedback Causal-based feedback \ Attribute Isolation	Pre Training Bio Feedback During Training Stress Exposure Training (SET) /Stress Inoculation Training (SIT) Post Training Metacognition Strategies	Pre Training Motivation Strategies During Training Emotional Engagement Variety/Increasing Complexity Novelty, Unexpected Challenges High fidelity Scenarios Post Training Mastery Orientation

Decision-making Learning Strategies
There are several learning strategies which can be used to enhance DM skills (Carroll et al., 2013). Pre-training exercises include: planning exercises which require trainees to layout the plan for how they will accomplish a goal have been effectively utilized (Blackburn et al., 2004), crystal ball exercises in which a plan is scrutinized for potential failure points by assuming that a 'crystal ball' indicates the current assessment is wrong and it is necessary to explain why (Cohen et al., 1998), premortem exercises which assume a plan has failed and require the trainee to identify plausible reasons for the failure in order to critique the plan (Veinott et al., 2010), and Advanced Organizers, such as outlines, narratives, and audio or video multimedia, which assist learners in attending to the most appropriate stimuli and effectively interpreting information during training (Vogel-Walcutt et al., 2010; Mueller-Hanson et al., 2005). A key learning strategy which can be utilized during training is an Event-Based Approach to Training (EBAT; Fowlkes et al., 1998) in which training opportunities are systematically created by presenting events designed to elicit specific skills or behaviors such as decision-making. After action review techniques such as error-based or causal-based feedback (Carroll et al., 2008, Carroll, 2010) provide the opportunity to target decision-making at the process level. Errors are considered to be valuable opportunities to clarify misunderstandings in learners (Mory, 2004) and the identification of underlying causes of deficiencies allows instructors to provide meaningful feedback (Salas et al., 2007). This can be combined with specific learning strategies such as attribute isolation in which central attributes of target concepts (e.g., why cues are critical for a situations or indicative of an impending threat) are highlighted to improve general understanding of phenomenon (Mason & Bruning, 2001).

Stress Response Learning Strategies

There are also various learning strategies that can be used to target an individual's stress response during DM performance (Carroll et al., 2013). Biofeedback is a process by which individuals learn to control functions such as blood pressure, salivation, sweat gland activity, and cardiac activity through feedback signals from sensors monitoring physiological responses (Calderon & Thompson, 2004). Stress exposure strategies such as Stress Inoculation Training (SIT; Saunders et al., 1996) and Stress Exposure Training (SET; Driskell & Johnston, 1998) have also been shown effective in increasing a trainee's ability to cope with stress (Sheehy & Horan, 2004; Saunders et al., 1996; Meichenbaum & Deffenbacher, 1988). Metacognition strategies can be utilized to facilitate awareness of how one perceives and thinks about stressors as well as enable accurate appraisal of a stressor by assessing best, worst, and most likely outcomes (Narayanan, 2009).

Adaptability Learning Strategies

Multiple learning strategies can be used to increase the adaptability of a decision maker (Carroll et al., 2013). Pre-training strategies include techniques to increase a trainee's motivation to learn, active engagement in training, and recognition of relevancy to their job (Mueller-Hanson et al., 2009). There are also several learning strategies which can be applied during simulation training exercises, including variety (e.g., variation of situations, decisions), increasing difficulty/complexity over time, novel and unexpected challenges presented to stretch the trainee, and the use of high fidelity scenarios that closely mimic the types of situations they will encounter in the field (Mueller-Hanson et al., 2009). Post training learning strategies such as mastery orientation drive feedback focused on the process not the outcome, and can also be utilized to increase adaptability.

From the research reviewed on decision-making under stress, resilience, measures, and learning strategies, an overall conceptual model for training decision-making under stress was developed and is described in the section below.

3.2.5 STAR-DM Conceptual Model

Within small unit leaders, the ability to demonstrate resilience in the face of a variety of stressors is critical to mission success. Therefore, training Warfighter resilience during decision-making should focus on two main objectives 1) enhancing adaptability through stress appraisal skills and 2) developing physiological and psychological coping strategies that support recovery (i.e., bounce-back) and effective performance despite the experience of stress. Based on these two objectives, a framework for training resilience in decision-making was proposed during the early stages of this effort, based on the pathways model of resilience (adapted from Carver, 1998; Figure 3). Resilience research has shown that when a person encounters a significantly stressful event, he/she will either 1) succumb to the stress and performance will degrade to the point of failure, 2) have degraded performance, but survive by maintaining performance levels that enable them to continue to operate sub-optimally, 3) recover to pre-stressor levels, or 4) thrive in the face of the stressor (Carver, 1998; Mancini & Bonanno, 2010).
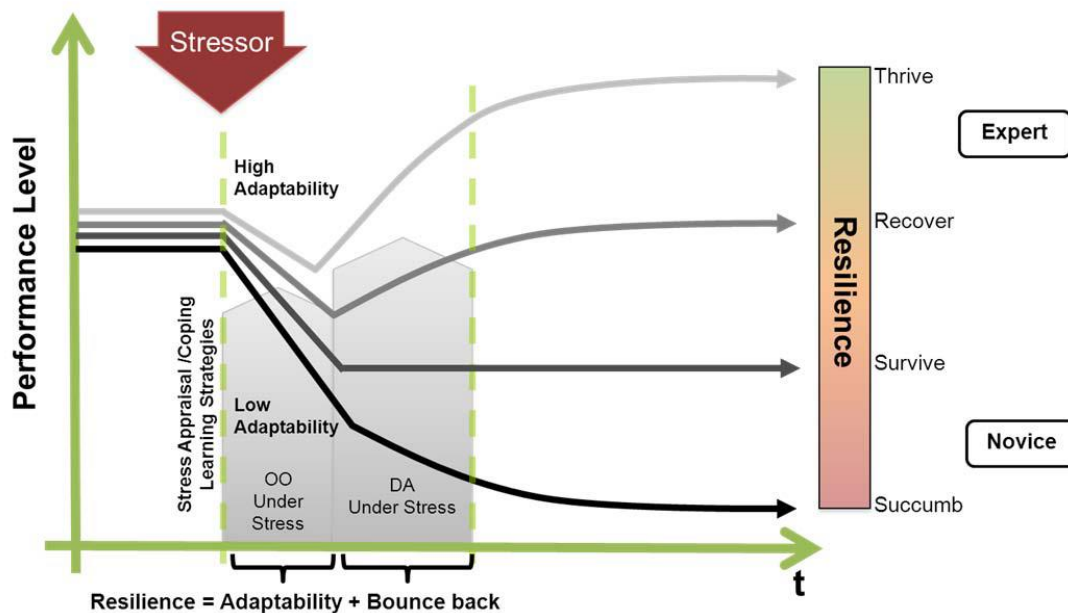
Figure 3. Model for Training Resilient Decision Making

In order to support resilience training, it was proposed that adaptability and bounce-back are components of a performer's resilience. Specifically, resilience can be modeled as a function of 1) the time needed to recognize that the cues have changed and the need to change action, which aligns with the initial performance drop resulting from a stressor – the adaptability phase and 2) the time to consider decision alternatives and act appropriately to the cue – the bounce-back phase. A person's level of adaptability is represented by the initial performance drop resulting from the stressor, wherein a highly adaptable person is able to recognize the stressor and need to change course of action (see adaptability phase in Figure 3). This includes accurately assessing best case/worst case/most likely case as a result of exposure to the stressor, identifying performance elements required to achieve successful performance and recognizing when adjustment from one strategy to another is needed to address the condition represented by the stressor (Grisogono, 2006). Adaptability in the early stages of the DM process (Observe/Orient), wherein an individual is perceiving environmental cues and assessing if what they represent is critical. Once a person has recognized the effects of a cue and identified strategies to address what it represents, the second phase of resilience kicks in - a person's ability to recover from the stressor - a.k.a. the bounce-back phase (see bounce-back phase in Figure 3). A person's ability to bounce-back is represented by both the amount and rate of bounce-back, wherein a highly resilient person is able to 1) maintain or regain balance physiologically in the presence of the stressor, 2) maintain or regain focus and change their thoughts/behaviors in a positive manner as needed to complete tasks despite presence of stress, and 3) recover from or adjust to the stressor, thereby maintaining or regaining effective performance levels across a range of tasks, situations, and conditions (Lazarus, 1966). Bounce-back is therefore critical for the latter stages of the DM process (Decide/Act) wherein an individual is now evaluating decision alternatives under the conditions that the stressor represents and selecting and executing courses of actions predicted to be most successful in the face of the stressor.

The underlying assumption of this model is that although many competent decision makers have been trained to adequate levels of DM performance void of stressors, when they encounter a stressor, their performance may be impacted in a variety of ways depending on their resilience – i.e., their adaptability and ability to bounce-back from stress. It is theorized that monitoring an individual's DM performance, both process (e.g., DM stages such as OODA) and outcome level, in hand with their physiological stress responses (e.g., heart rate, galvanic skin response) will enable progress along the theorized curve to be assessed and their resilience pathway (i.e., succumb, survive, etc.) to be diagnosed. Diagnosis of this pathway and where breakdowns in the DM process occur will facilitate delivery of individualized learning

strategies targeted to build resilience (i.e., adaptability and bounce-back) into the DM process and trainee in general.

One of the two objectives of resilience training should be enhancing Marine's adaptability. Specifically, given the complex and continually changing environments that Marines are required to operate in, a critical component to timely and accurate decision-making is the rate at which they are able to operationally recognize the need to change a course of action (COA) based on the underlying causes of the experienced cues. The goal of adaptability training should be to train, and in turn measure, a Marine's ability to engage 'intelligent' context-appropriate and flexible assessment of the environment, be robust to adverse and stressful events that represent danger, create – when necessary - new strategies in real-time, as well as to learn from and adapt to lessons-learned via experience (i.e., encode information about the past and use it to be more effective in the face of future stressors). The other objective of resilience training should be to enhance the ability of a Marine to bounce-back from the impact of stress by developing physiological and psychological coping strategies that support recovery and effective performance despite the presence of stressors. This should, in turn, allow for selection from among plausible COAs while preferentially retaining/discarding variations that enhance/decrease probability of success (Grisogono, 2006). Over time the performer should internalize variations that tend to increase the probability of success, thus becoming a resilient decision maker.

Figure 4 summarizes learning strategies which can be leveraged to enhance adaptability and bounce-back. Once effectively integrated into a training regime, such training should provide individuals with the ability to respond quickly and intelligently to constantly changing and stressful environments by thinking critically and flexibly, being comfortable with ambiguity and decentralization of control, dealing with uncertainty and risk, and rapidly recovering and adjusting based on a continuous assessment of the situation (Wong, 2004). All of these skills are critical in today's military.
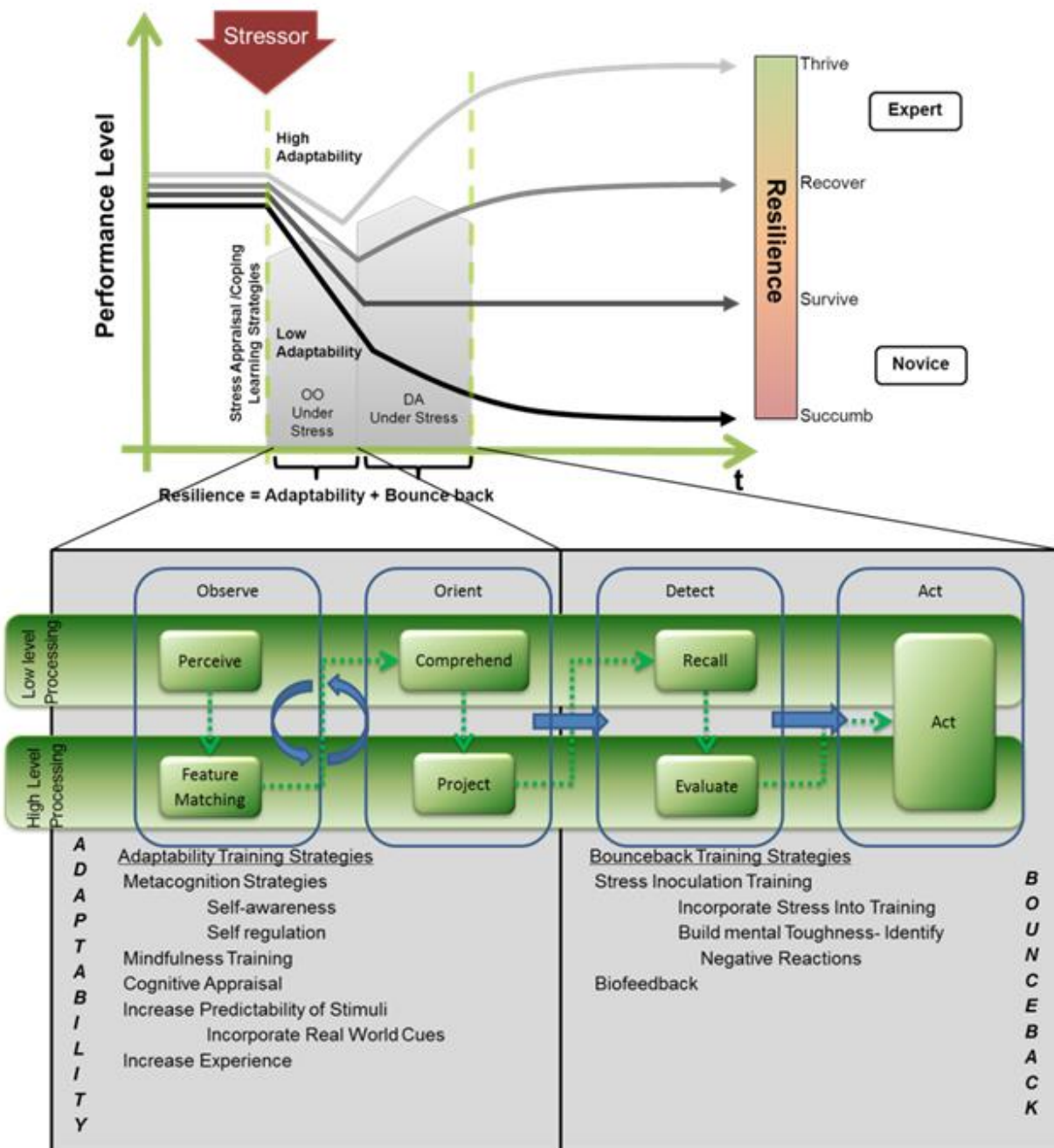
Figure 4. Integrated Model of Resilience, Decision Making, and Learning Strategies

3.3 Empirical Research

3.3.1 Experiment 1

The first experiment under the STAR-DM effort was designed to address the following research questions:
1. Can stress be induced with VBS2 scenarios, and if so, how does it compare to the gold standard socio-evaluative stressor?
2. Which physiological measures are most indicative of stress and resilience?

3. Which DM measures are most discriminative/predictive?

The gold standard socio-evaluative stressor under study was the Trier Social Stress Test (TSST). Based on the foundational research, it was hypothesized that the TSST would induce the highest amount of stress in participants and that, given the additive nature of stress events, the inclusion of a socio-evaluative stressor prior to STAR-DM scenarios would lead to higher levels of stress experienced during the training simulations.

3.3.1.1 Methods

Forty people, 33 males and 7 females, ages 18 to 35 participated in the study. Participants were split into two groups, a control group who only received the VBS2-based complex, military-relevant simulation scenarios and the experimental group who received the TSST prior to the scenarios. The VBS2 scenarios were designed to be increasing in difficulty and level of stress. In order to assess the stress response and resilience of participants, performance measures (statistics from the VBS scenarios on how well mission goals were achieved), physiological measures (e.g., heart rate variability), and subjective stress measures (State Trait Anxiety Inventory; STAI) were collected. An overview of the experimental procedure and timeline is outlined in Figure 5 below. For additional details on the experimental procedure, methods, and scenarios see Winslow et al., 2015.

Conditions	Baseline	Social Evaluative Phase	Familiar-ization	Scenario #1	Scenario #2	Scenario #3	Scenario #4	Scenario #5
Control	Sit on couch and relax	Control Task	VBS2 training, practice scenario	Low Stress	Moderate Stress	Moderate Stress	High Stress	High Stress
TSST		TSST		*Scenarios counterbalanced to account for order effects				
Timeline	5 min	15 min	30 min	15 min	15 min	15 min	15 min	15 min

Figure 5. Experimental Procedure and Timeline per Group

3.3.1.2 Results

A summary of the key results from the experiment follows. Further discussion of the statistical analyses performed and results can be found in Winslow et al., 2015.
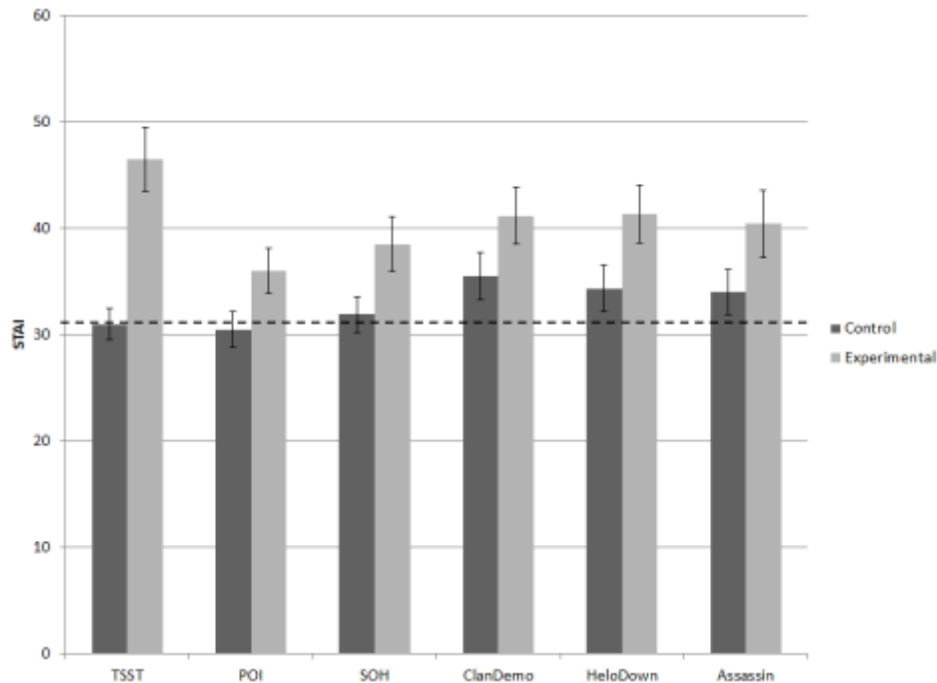
Figure 6. Experiment 1 STAI Results per Group

Figure 6 shows the average value of perceived stress for each group at each stage of the experiment [after the socio-evaluative stressor (which for the control group was a placebo version of the TSST) and each VBS2 scenario] where the dashed line indicates the average overall baseline value. As predicted, the TSST induced the highest level of perceived stress. The VBS2 scenarios induced low to moderate levels of perceived stress, with those who received the TSST experiencing higher levels of perceived stress during the subsequent scenarios. Between groups, the experimental group reported significantly higher self-reported anxiety/stress after the TSST ($p \leq 0.001$) and scenarios 1 (Person of Interest; POI), 2 (Sleight of Hand; SOH), and 4 (Helicopter Down; HeloDown) (all with $p \leq 0.05$) than the control group. Within groups, the control group's perceived stress during the scenarios was not statistically significant from baseline with the exception of the third scenario (Clandestine Demolition; ClanDemo). For the experimental group, a statistically significant increase from baseline was observed during the TSST, scenario 3 (ClanDemo) and scenario 4 (HeloDown) (both $p \leq 0.05$).
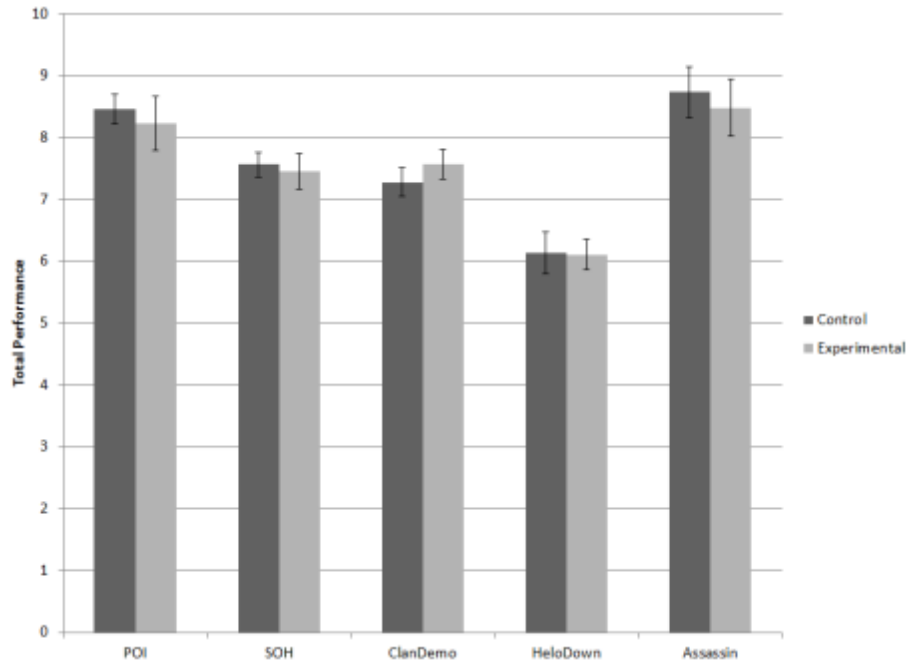
Figure 7. Experiment 1 Performance Results per Group

As predicted, performance decreased (see Figure 7) across VBS2 scenarios from high to low levels of difficulty/assumed stress with the exception of one scenario (scenario 5 – Assassin). There was not a statistically significant difference observed between the groups in terms of performance measures.
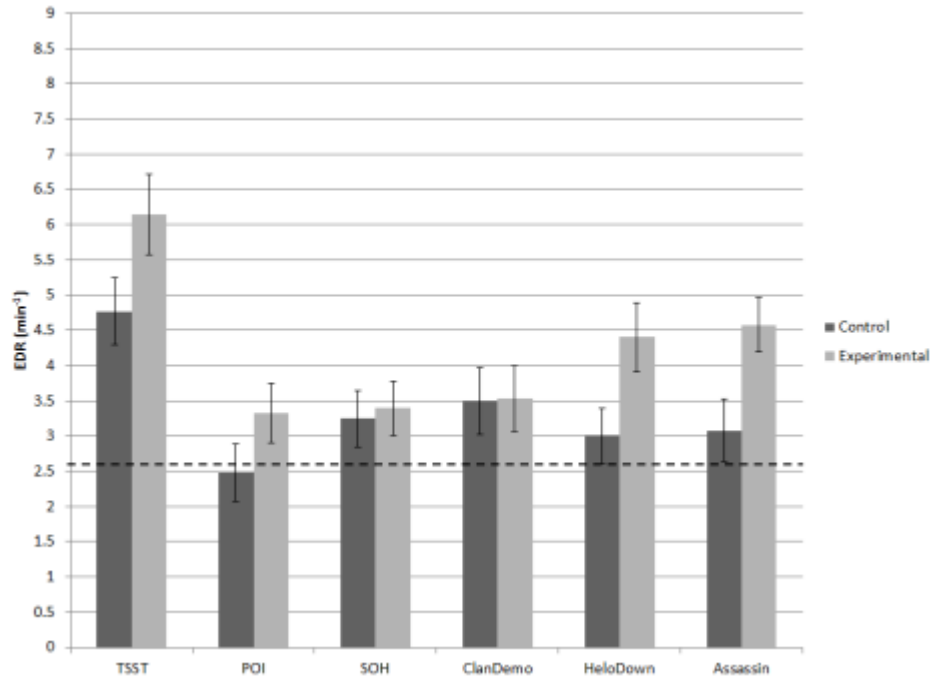

Figure 8 Experiment 1 EDR Physiological Results per Group

Figure 8 displays the average electrodermal response per group at each point during the experiment with the dotted line representing the average baseline value. As predicted, the TSST induced the highest levels of physiological response and the VBS2 scenarios tend to increase from low to mod/high levels.

The experimental group experienced significantly higher physiological response than the control group (p ≤ 0.05) during the TSST and scenarios 3 and 4.
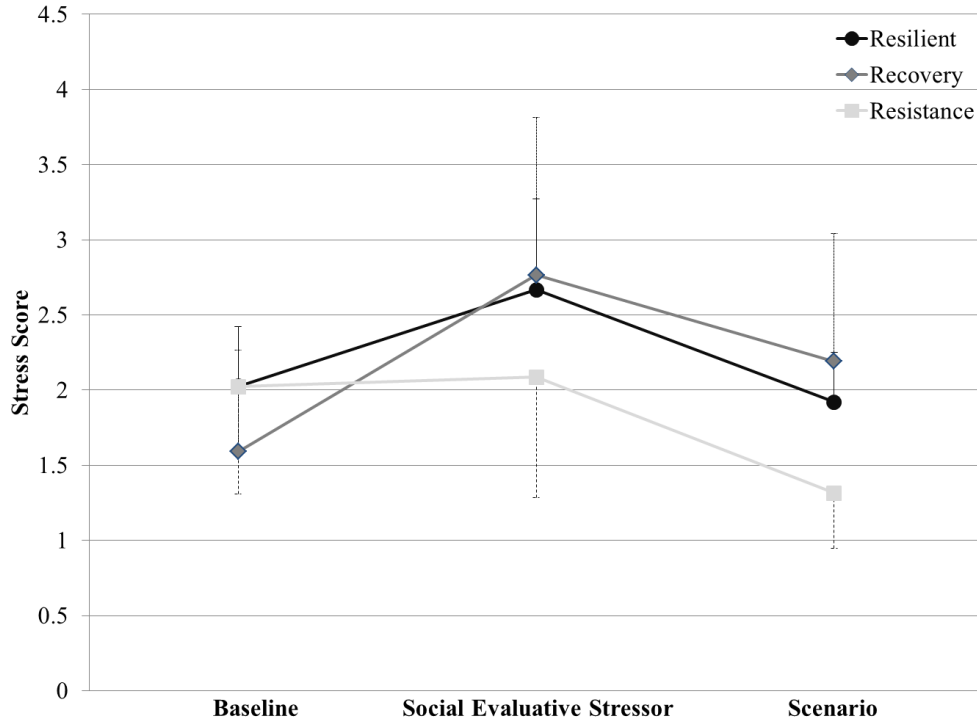

Figure 9. Experiment 1 Average Normalized Stress Score by Group During Baseline, TSST, and VBS2 Scenarios

A physiological stress score was defined using a normalized combination of heart rate and skin conductance level (see Dechmerowski et al, 2014 for more information) and the pattern of those scores was analyzed over the course of the experiment. Subjects were grouped into the resistant, resilient, and recovery trends as defined by Norris et al., 2009 (see Figure 9 above). The data was analyzed to see if it is possible to predict an individual's resilience classification and see how that classification affected their performance. Though inconclusive and requiring further study, results indicated that resilience can potentially be predicted using baseline cortisol and STAI data (Fig 10). Results also indicate that an individual's resilience level is potentially predictive of performance.
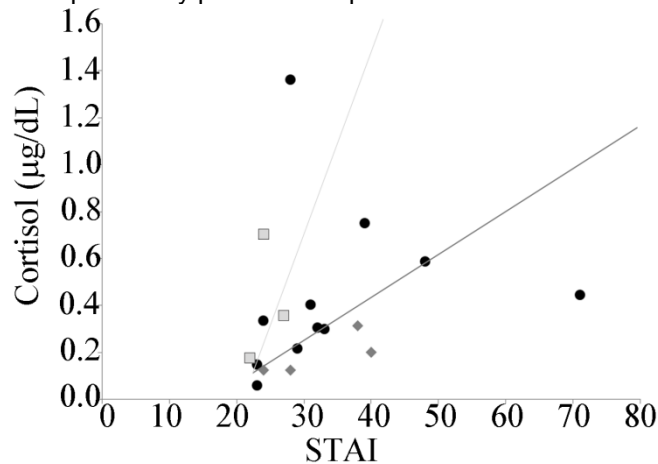

Figure 10: Decision Boundaries of Stochastic Gradient Descent Linear Classifier of Resilience Group Using Baseline Cortisol and Baseline STAI.

In addition to studying the physiological measures and overall mission performance, an analysis on the OODA process-level DM measures was conducted to evaluate if those measures are good predictors of overall outcome performance. These measures were shown to account for a significant amount of decision outcome performance with an R^2 values ≥ 0.7 in 13 of the 25 events and between 0.3 and 0.39 in 11 out of 25 events, with the Decide and Act measures being significant predictors in a half or more of the events.

3.3.1.3 Discussion
The results of this laboratory study support the hypothesis that in order to induce large amounts of stress during simulation based training, a socio-evaluative stressor followed by simulations specifically designed to incorporate stressful events are needed. The results show that simulation based stressors alone are likely not going to illicit a significant stress response but that the addition of external stress sources in conjunction with the training can produce stress effects, both perceived and physiological, that last for extended periods.

As the difficulty and stress increased over the scenarios the overall mission performance scores tended to decrease except on the final scenario. Though that scenario was initially rated high in terms of stress and difficulty, after conducting the experiments and getting feedback, it was determined that the interaction required with the scenario was much less complex, thus likely leading to reductions in perceived stress. Additionally, there was not found to be a significant difference in mission performance between the control and experimental groups over the scenarios, thus indicating that the increased stress induced by the incorporated TSST stressor was not sufficient enough to lead to performance decrements in those scenarios.

One potential limitation of the findings is that the test was conducted with non-military personnel thus drawing into question whether the findings would apply to Marines. Part of the impetus of the subsequent field study, which will be described later on, was to evaluate that question,

3.3.1.4 Conclusions
In summary, the key results from the experiment were:
- Stress can be induced in a simulation training context. However, the inclusion of a socio-evaluative stressor is key. In order to incorporate this stressor into the STAR-DM training, the training process includes a step where the Squad Leader has to plan the mission and brief the room and then receive feedback from a superior. Additionally, they receive an AAR debrief of their performance in front of their squad.
- Stress can be measured with the use of physiological sensors and the STAI. In terms of physiological measures, electrodermal response and heart rate are the best predictors. Those measures can be combined into an operational stress index which can be used to evaluate an individual's stress level throughout training.
- Resilience can be quantified.
- There is the potential to predict resilience based on baseline values of cortisol and STAI.
- An individual's resilience level is potentially predictive of their performance.
- Overall decision-making performance at the process level can be measured.

3.3.2 Experiment 2

The primary objective of the second laboratory experiment was to evaluate the effectiveness of incorporating training interventions into the STAR-DM training framework. The research question was:
- Which training intervention, between learning strategies that target DM skills or those that target stress skills, is most effective at improving DM under stress?

3.3.2.1 Methods
The study consisted of 63 participants, all male, between the ages of 18 and 30. One important demographic of the participant pool was computer gaming experience which was quite varied across the

group: 9 participants had zero or low experience, 14 had moderately low experience, 10 had moderately high experience, and 9 had high experience.

Experimental Design and Measures

The experimental design is shown in Figure 11. There were three study conditions; a control group, a group who received DM learning strategies, and a group that received stress learning strategies with biofeedback (BF). All participants completed the same series of steps throughout the study: Introduction, VBS2 familiarization training, pretest (socio-evaluative stressor and VBS2 scenario), education phase, acquisition (practice) phase, application 1 and 2 (each with a different VBS2 scenario plus feedback), and posttest (socio-evaluative stressor and VBS2 Scenario). Two different socio-evaluative stress induction techniques were used; the TSST and the Socially-Evaluated Cold Pressor Test (SECPT). Both the stress induction techniques, and the first and last VBS2 scenarios used in the pre and posttest, were counterbalanced to account for potential order effects. The red "C" in the figure denotes the points during the experiment that cortisol samples were taken. Table 6 provides a description of the three study conditions. For more details on the experimental design and test procedure please see Carroll et al. 2015.

Condition	Base-line	VBS2	Pretest	Education	Acquisition	Application 1	Application 2	Posttest
Control	Apply sensors, question naires, Relax (5 min)	Training + Practice Scenario	TSST* + Scenario 1 (High Stress) *Counter-balanced	Triage presentation	Practice triage steps	Scenario 2 + outcome feedback	Scenario 3 + outcome feedback	SECPT* + Scenario 4 (High Stress) *Counter-balanced
DM Learning Strategies				Decision Making Process presentation	Practice error-based DM feedback	Scenario 2 + error-based feedback	Scenario 3 + error-based feedback	
Stress Learning Strategies	C		C	Stress Effects, Coping presentation	Practice coping strategies + biofeedback	Scenario 2 + Biofeedback + Outcome feedback	Scenario 3 + Biofeedback + Outcome feedback C	C
Timeline	30 min	40 min	40 min	15 min	10 min	30 min	30 min	

Figure 11. Experiment 2 High Level Experimental Procedure

Table 6. Description of Experimental Conditions

Cond.	Education (15 min ppt.)	Acquisition (10 min Practice)	Application (1 hr, 2 VBS2 Scens)
Control	Presented Simple Triage and Rapid Treatment (START) Combat Triage decision making strategy, including steps for how to determine priority of treatment based on health condition	Practiced making triage decisions using the START strategy	Received **outcome feedback** after each scenario based on observer checklist.
Decision Making Process Feedback Strategy	Presented concepts of process level feedback, the OODA loop, the impact of stress on each stage of OODA, performance strategies for improving the OODA loop and error management instructions	Practiced interpreting and delivering process level feedback by analyzing previous VBS2 situations	Received **outcome and process level feedback** after each scenario based on observer event-based checklist
Stress Bio-Feedback Strategy	Presented concepts of stress, how it affects the body physiologically, and biofeedback (how it works and examples). Tactical breathing technique presented via mobile application – sound of an ocean wave presented to pace breathing.	Practiced tactical breathing while recalling event in life that makes them anxious. Biofeedback provided: sound of ocean wave when physiological response above baseline	Received **outcome feedback** after scenarios based on observer checklist and **biofeedback during stressor/scenario**: sound of ocean wave when physio response above baseline (tactical breathing reminder)

The primary experimental measures were:

Physiological & Psychological Stress Response Measures:
- Biopac MP-150:
    - Electrodermal Activity (EDA) – Non dominant hand
    - Electrocardiogram (ECG) – 3 Lead (Heart Rate (HR) / HR Variability)
    - Electromyography (EMG) – Trapezius
    - Respiration Rate (Chest Strap)
- Physiological Stress Level: Aggregate of electro-dermal and cardiovascular metrics
- Saliva: Cortisol (4 times during study)
- State Trait Anxiety Inventory (STAI) – State portion

Decision Making (DM) Performance: Effectiveness of DM process calculated by averaging below scores across DM process for each event (Event Level DM score) and across a scenario (Scenario DM Score):
- Observe: Did participant observe decision critical cues?
    - Score of critical areas of interest that they focused on (observer checklist)
- Orient: Did participant assess situation effectively?
    - Score of critical situation factors reported (observer checklist)
- Decide: Did participant consider/select effective course(s) of action?
    - Effectiveness score of COA reported (observer checklist)
- Act: Did participant effectively execute course of action
    - Effectiveness score of COA executed (observer/system)

Mission Performance: Calculated by aggregating the below scores using the following method: 1) scores normalized to data point between 0-10 based on sample data range, 2) scores weighted based on importance in each scenario, 3) weighted scores combined:
- Mission Success (if mission objectives were met per the observer checklist)
- Time to complete mission (minutes, system collected)
- Survivability (number of shots taken; system collected)
- Civilians killed (number, system collected)

Since many of the DM measures relied on data collected using the observer checklist (see example in Figure 12 below), an interrater reliability (IRR) analysis was performed to ensure consistency in those collected measures. The process for collecting data using the checklist was that one of three observers would watch a participant navigate through the scenario and for each event would check off the appropriate boxes corresponding to their statements and actions. Note that participants were asked to talk thorough their thoughts out loud so that the observers could determine their COA considerations. Each event and scenario was different (e.g. there may be multiple key items of interest to detect in one given event, but only one in another), but all were scored similarly. Fleiss' Kappa (KF) was calculated for each of the four scenarios used in the experiment with resulting values between 0.80 and 0.92. All of the results fall within either the generally accepted "strong" or "near complete" agreement ranges, indicating strong consistency among the raters.

Scenario: Assassin	Check √ appropriate boxes			
Event 1: Convoy Arrival				
Detects	☐ Boss (100)	☐	☐ Nothing (0)	☐ Other:
Recognizes	☐ Group of people are meeting (50)	☐ Boss is the target (50)	☐ Nothing (0)	☐ Other:
Courses of Action	Wait for boss to stand still (50) ☐ Considered ☐ Chosen	Shoot the Boss (50) ☐ Considered ☐ Chosen	Nothing (0) ☐ Considered ☐ Chosen	Other: ☐ Considered ☐ Chosen
Actions Taken	Shoot one shot at Boss (100) ☐ Performs	Shoot multiple shots at Boss (50) ☐ Performs	Doesn't shoot at Boss (0) ☐ Performs	Other: ☐ Performs
Outcome	Boss is dead (100) ☐ Occurs	☐ Occurs	Boss is alive (0) ☐ Occurs	Other: ☐ Occurs

Figure 12. Example of Observer Checklist

3.3.2.2 Results

Preliminary correlational analysis revealed that DM performance in the pretest scenario was significantly correlated with computer gaming experience ($r = .39$, $p = .01$). This finding is not surprising in that it makes sense that those more comfortable playing computer games would have less difficulty interacting with and be more comfortable with the early scenarios which could lead to better performance. Therefore, computer gaming experience was used as a covariate throughout the analysis. Additionally, the preliminary analysis showed that the change in DM performance from pretest to posttest was significantly correlated with the pretest scenario ($r = .47$, $p = .01$). In other words, despite efforts to equalize difficulty and stress of the two scenarios (Clandestine Demolition (CD) and Helo Down (HD)), one scenario (HD) had much lower performance than the other. Figure 13 below shows the DM performance of the two scenarios, pretest and posttest. Those who received the hard scenario (HD shown in blue) first showed improvement in the posttest that was partially due to their posttest scenario (CD shown in red) being easier.
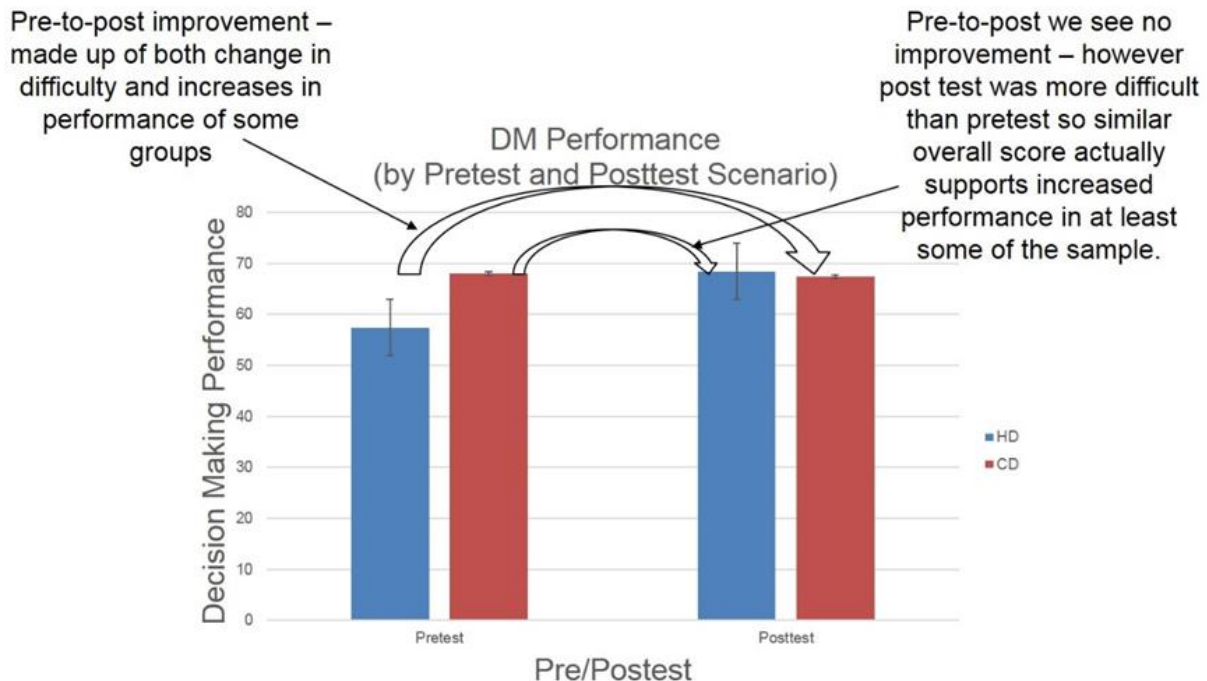

Figure 13. Decision Making Performance by Pretest and Posttest Scenario

In breaking down performance in terms of each stage of the OODA loop, the differences in DM performance can be better determined. Figure 14 shows the overall average score per OODA stage for the CD and HD scenarios. The differences between CD and HD are negligible in the Observe and Orient stages, but a big performance difference is seen in the Decide and Act stages indicating HD is more difficult. Given the significance of pretest scenario in the correlational analysis, pretest was also used as a covariate.
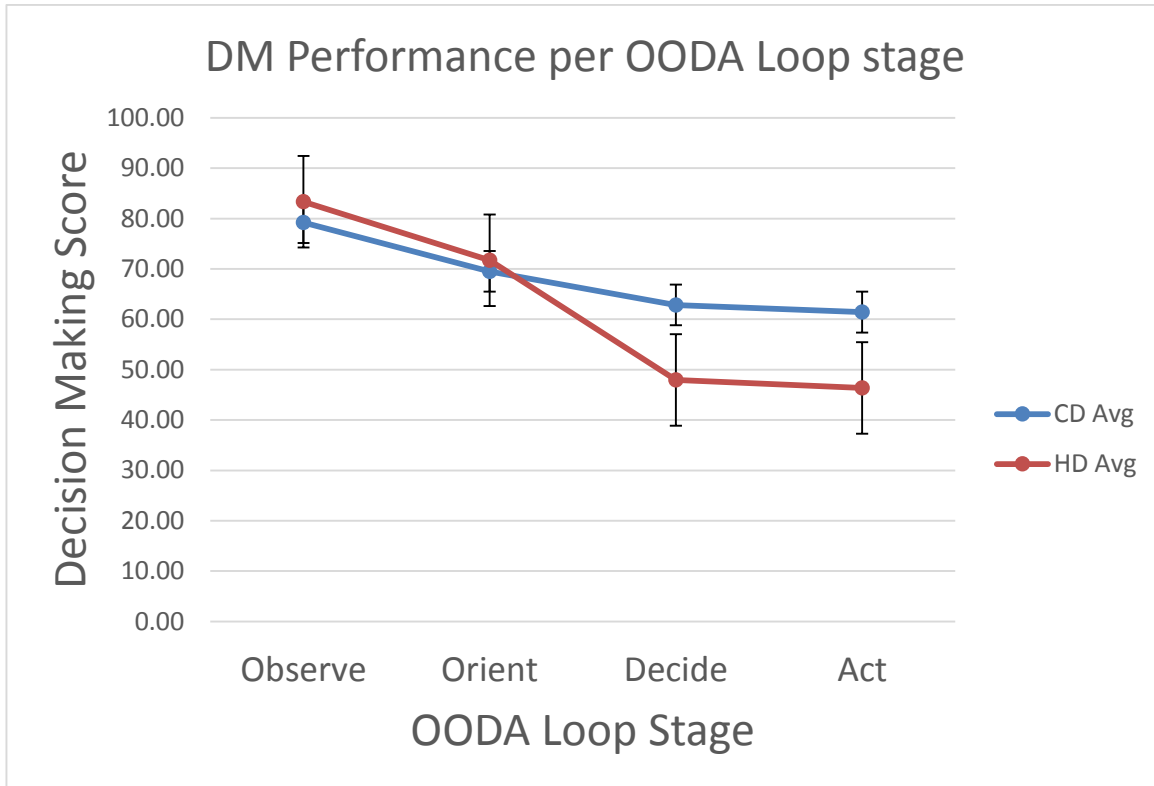

Figure 14: Decision Making Performance at Each OODA Loop Stage

Next, the data was analyzed to determine the findings for the three hypotheses underlying the experiment. The first hypothesis was that DM learning strategies would result in significant DM performance improvements from pretest to posttest compared to control. The average change score for each condition was analyzed (see Figure 15) in order to evaluate the first hypothesis. When all conditions were considered together, the trial by condition interaction was not significant ($F(2, 58) = 3.23$, $p = .14$, $\eta^2 = .06$). However, when comparing only the DM and Control groups (Figure 16), there was a significant trial by condition interaction wherein the DM group had significantly greater decision-making performance improvements than the control group ($F (1, 38) = 4.94$, $p = .03$, $\eta^2 = .12$).
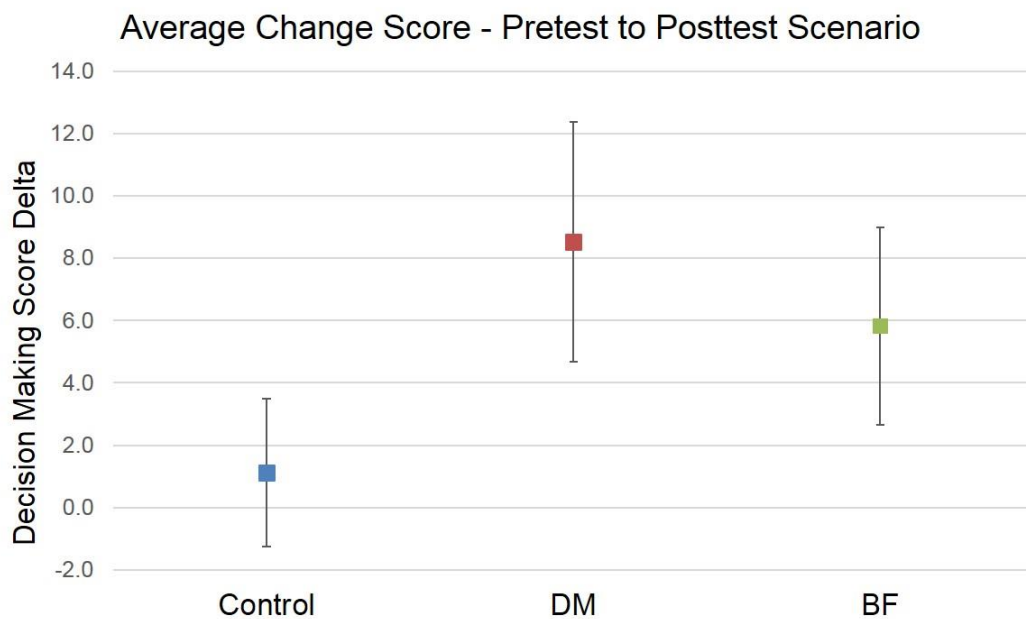
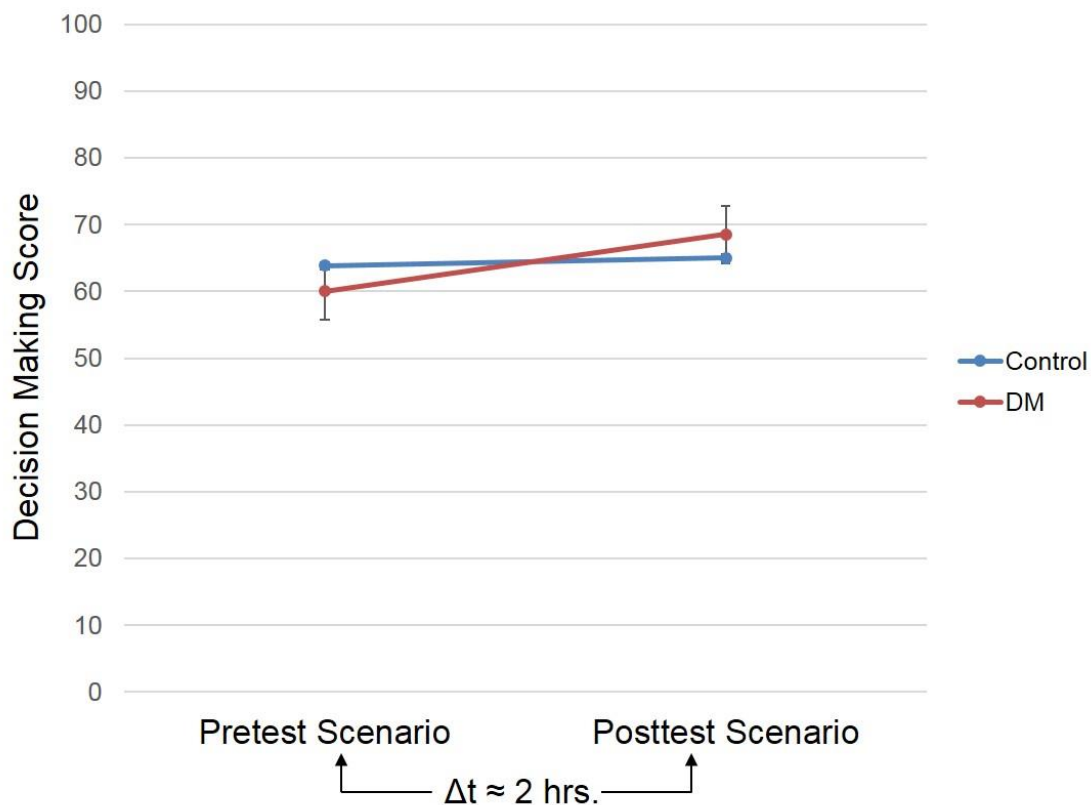*Figure 15: Average DM Change Score from Pre to Posttest*

Figure 16: Decision Making Performance for Control and DM Conditions

The second hypothesis was that stress learning strategies would result in significant reductions in stress response (physiological and psychological) from pretest to posttest compared to control. As in Experiment 1, physiological stress was measured using a stress score which is a classifier developed and validated under another effort (Dechmerowski et al. (2014)) that is made up of heart rate variability and electrodermal activity metrics and is baseline normalized by individual. Figure 17 shows the average stress score values by group during the different stages in the experiment. Though there was not sufficient sample size to show overall significance across all conditions, results suggest both BF and DM learning strategies led to reductions in stress response compared to control. When evaluating the difference from pre to posttest stress response (Figure 18), the BF group saw a significant decrease in physiological stress response from Pretest Stressor to Posttest Stressor (p = 0.024). The Control group (p = 0.386) and DM group (p = 0.320) did not.
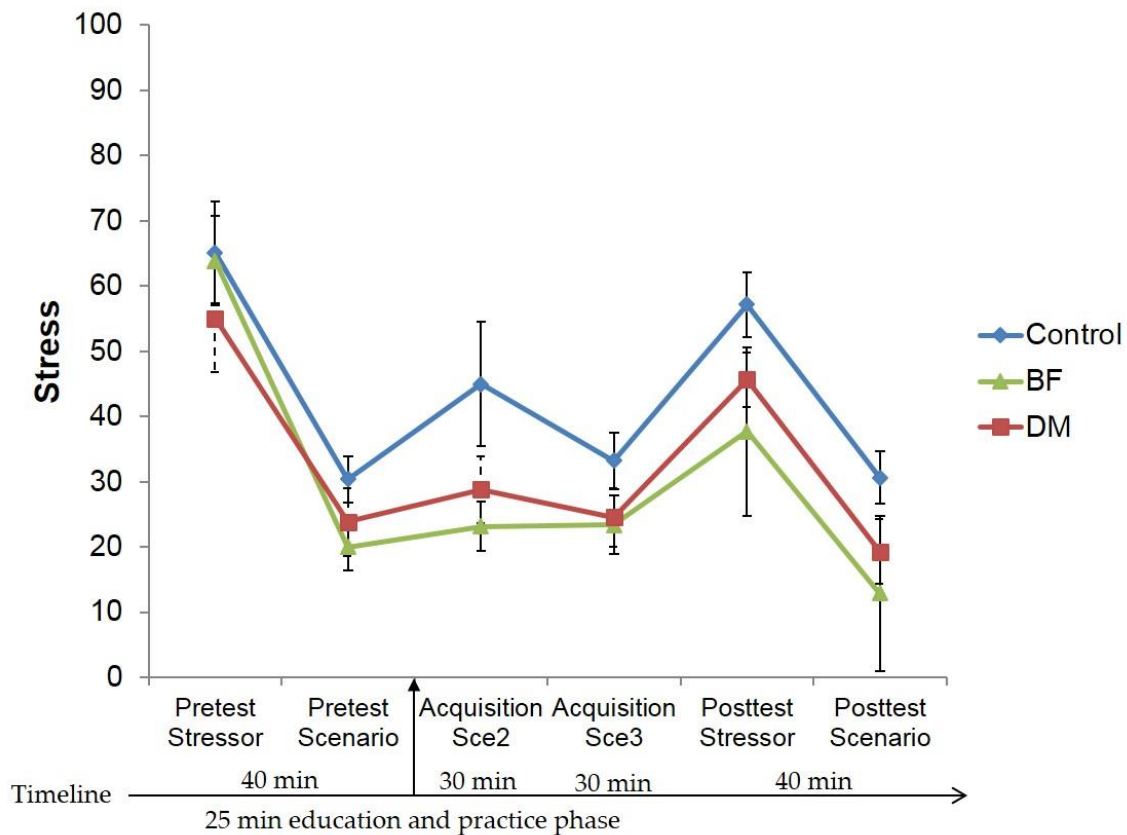

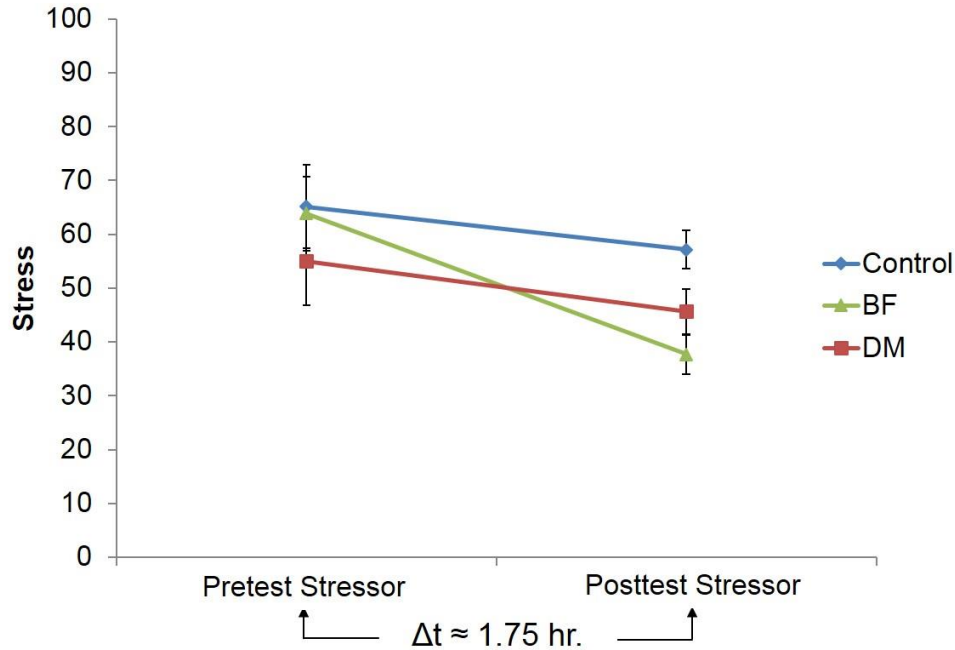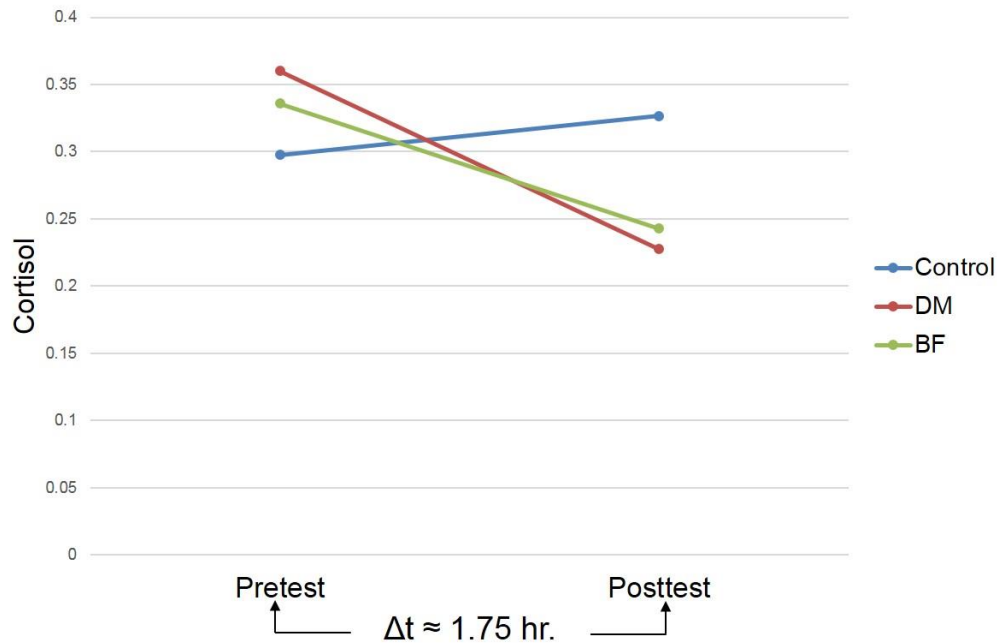Figure 17: Average Stress Response by Group by Experimental Stage

Figure 18: Average Stress Response by Group by Experimental Stage

Cortisol levels compared from pre to posttest show that both the DM and BF groups had a significant decrease in cortisol response from pretest to posttest (BF p = 0.047; DM p = 0.010) while the control group did not (p = 0.636). See Figure 19.

* Pretest/posttest cortisol measurements taken after the pretest/posttest stressor and scenario

Figure 19: Average Cortisol Level by Group from Pretest to Posttest

When evaluating perceived stress using the STAI there was not a significant decrease in perceived stress from pretest to posttest (see Figure 20). This is likely due to administration of the STAI after the scenario which in Experiment 1 proved to be a recovery period.

Figure 20. STAI by Group

The third hypothesis was that stress learning strategies would lead to improved resilience classification (e.g., from recovery to resilient) from pretest to posttest compared to control. However, results show that there was not a significant change in resilience classification from pretest to posttest in any group. This indicates that changes of resilience level may not be trainable in a short-term experiment.

One additional analysis was performed to evaluate if there was an overall mission performance improvement in the BF and DM groups compared to control. Although there was not enough evidence to show statistical significance, participants who received control learning strategies had negligible performance changes, while there appeared to be increases in performance from participants in both the DM and BF conditions (Figure 21).
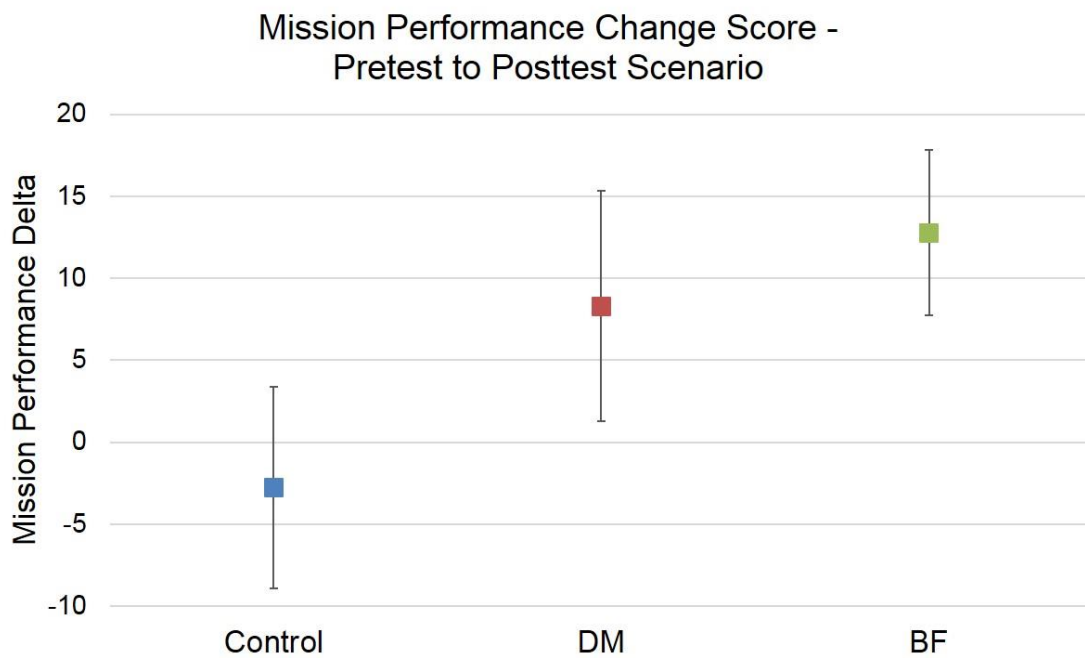

Figure 21. Mission Performance Change Score from Pre to Posttest

3.3.2.3 Discussion

The results of the second laboratory study support the hypothesis that the DM learning strategy which combined both process level and outcome feedback, led to significantly greater increases in DM performance than the outcome feedback alone received by the control group. This is in line with findings from the literature (Earley et al., 1990; Carroll, 2010) and provides support for utilizing such a strategy to target DM performance in training. The process level feedback allows for the pinpointing of where in the DM process the breakdown occurred so the performer can focus their attention on task strategies used in deficient sub steps, allowing a more effective and efficient learning experience.

The inclusion of stress learning strategies combined with biofeedback reduced the stress response of individuals. By helping the trainee recognize when they are experiencing stress and giving them strategies to reduce their stress response, individuals are able to better regulate their stress levels. Both learning strategies appear to improve overall performance but more research is needed in order to prove that assertion.

These results must be viewed with caution as there were several limitations of the studies. One limitation of both laboratory studies was the amount of training time. Given the limited amount of time participants were available, both training times were severely limited. Decision making is a complex skill which depends heavily on building up one's experience base, something not possible in one to two training scenarios.

3.3.2.4 Conclusion

The results from the second lab experiment indicate:
- Process level feedback improved decision-making performance,
- Biofeedback reduced stress response,
- The resilience classification hypothesis was unsupported indicating changes in resilience classification level through training may require more time,
- Both process-level feedback and biofeedback showed promise for increasing overall mission performance.

3.3.3 Field Study

The STAR-DM Field Study had three primary research questions that it aimed to address:
- Can stress be induced in Marines utilizing simulation-based training?
- Does the STAR-DM training approach improve decision-making performance?
- Do the performance improvements transfer to the field?

A summary of the experimental methods, design, execution, results and analysis follows. For detailed information see Carroll et al., 2014 & Carroll et al., 2015.

3.3.3.1 Methods

Thirty male Marine Corps Sergeants (E-5) with Squad Leader experience enrolled in the ISULC course at the SOI-E served as study participants. After a study introduction, all participants received a computer based Situational Judgment Test (SJT) as a pre-test. The group was then split into the control and experimental groups and received approximately 8 hours of training with the control group (made up of 8 leaders) receiving three scenarios created by the simulation lab at SOI-E and the experimental group (5 leaders) receiving five scenarios of the STAR-DM SLTPs. All trainees then completed a post-test SJT and then a series of field exercises (FEX). Figure 22 shows the experimental flow and Table 7 shows how the participants were split into experimental group Squad Leaders and teammates and control group leaders and teammates.
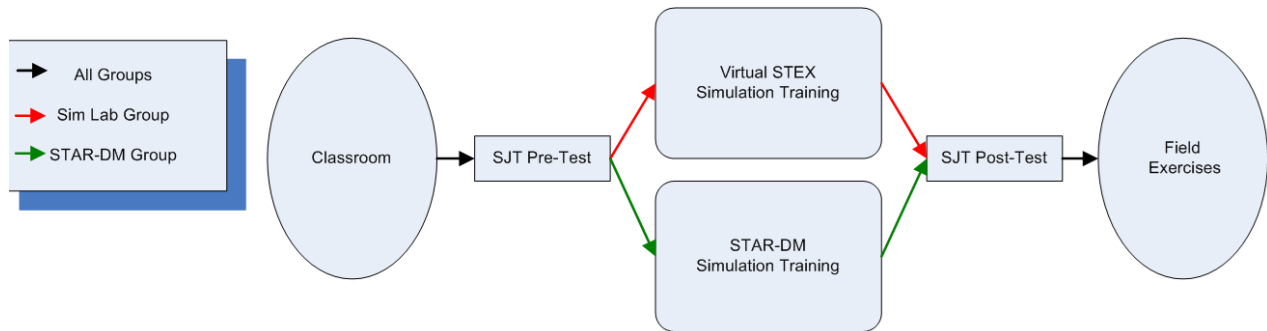
Figure 22: Field Study High Level Experimental Procedure

Table 7. Group Descriptions

Condition	Focus of Study	Not Focus of Study
Experimental	*Experimental Group Squad Leaders* (5) • Acted as Squad Leader during training • Received process level feedback • Wore physiological sensors	*Experimental Group Teammates* (10) • Did NOT act as Squad Leader during training (therefore, no feedback received) • Did not wear physiological sensors
Control	*Control Group Squad Leaders* (8) • Acted as Squad Leader during training • Received traditional feedback • Wore physiological sensors	*Control Group Teammates* (7) • Acted as Squad Leader during training • Received traditional feedback • Did not wear physiological sensors

Measures

The primary DM measures that were utilized in the study were pre and posttest competency as assessed by SJT ratings compared to subject matter experts. To assess training transfer, DM expertise level was assessed during the field study by instructors using the Behaviorally Anchored Rating Scale (BARS) to evaluate trainees in key performance areas (KPAs).

To measure psychological stress, the STAI was used to measure perceived stress and the Connor-Davidson Resilience Scale (CD-RISC) was used to measure the trainee's stress coping ability. A 10-point Likert scale questionnaire was also administered to capture trainee reactions to the stressfulness of the training they received.

Multiple physiological measures were collected during the study using the Biopac MP-150. However, as found in prior studies, EDA and HRV were shown to be the best measures for discriminating a stress response so these two measures were the primary ones utilized.

Procedure

The test procedure is outlined in Table 8. Training for both groups consisted of approximately eight hours of VBS2 simulation-based training which began after the study introduction and pretest. The STAR-DM and Sim Lab training approaches are outlined in Figure 23. In the control group, an instructor would interact with the simulation to elicit decision events and enact COAs that were chosen by the squad. An AAR of the squad's response to the event and planned COA was given by the instructor after each event. In the STAR-DM group, each squad member interacts directly with the VBS2 scenario to make decisions and enact responses to events that occur. After each event, the instructor provides overall feedback on mission and decision event performance. They also provide process level feedback using an OODA checklist to help trainees understand where breakdowns occur. This checklist includes: 1) cues detected/not (Observe), the situational factors recognized/not (Orient), the effectiveness of COAs chosen/not (Decide) and the effectiveness of COA execution (Act). Following the training, a posttest was

given. Then two weeks later, the participants were evaluated during two field exercises for transfer of training.

Table 8: Field Test Procedure by Day

Day(s)	Activity
1	Study introduction, informed consent forms and questionnaires completed
2	SJT pretest, split into control and experimental conditions, begin VBS2 simulation-based training
3	Complete VBS2 training (~8 total hours over 1.5 days), SJT posttest
	2 weeks after posttest
4-7	Series of two field exercises, BARS used to assess transfer performance on KPAs

STAR-DM Approach
1. **"Road to War" & Operational Update** –multimedia video

2. **Mission Orders** – Verbal

3. **Mission Planning & Issue Tasking**– work individually, briefed to entire room, public evaluation and feedback

4. **Mission Execution in VBS2** – first person, dynamic, interactive, stressors incorporated

5. **Assessment and Debrief** – Event-based checklist to assess and structure debrief

Sim Lab Approach
1. **"Road to War" & Operational Update** – verbal and sand table

2. **Mission Orders** – Verbal

3. **Mission Planning & Issue Tasking**– worked as team, briefed to COC over radio, feedback in front of team

4. **Mission Execution in VBS2** – top down view, static, not interactive, stress not the focus

5. **Assessment and Debrief** – Overall assessment form to assess and structure debrief

Figure 23: Description of Training Content and Structure Per Condition

3.3.3.2 Results

Change in DM competency was calculated by computing the difference between the SJT pre and posttest scores. Results indicated that the groups were significant ($F_{(3, 26)} = 3.15$, $p = .04$, $\eta^2 = .27$), with the experimental group Squad Leaders having the greatest improvements from pre to post test. Pairwise comparisons showed the experimental Squad Leader group was significantly different than both the experimental teammate and control teammate groups (both $p < 0.05$). Control group Squad Leaders were also significantly different than control group teammates ($p = 0.5$). Although it appears that the STAR-DM leaders had the greatest improvement in DM competency, there was not sufficient sample size to show statistically significant difference from the control group leaders. See Figure 24 for graph of results.

Change in Decision Making Competency per SJTs
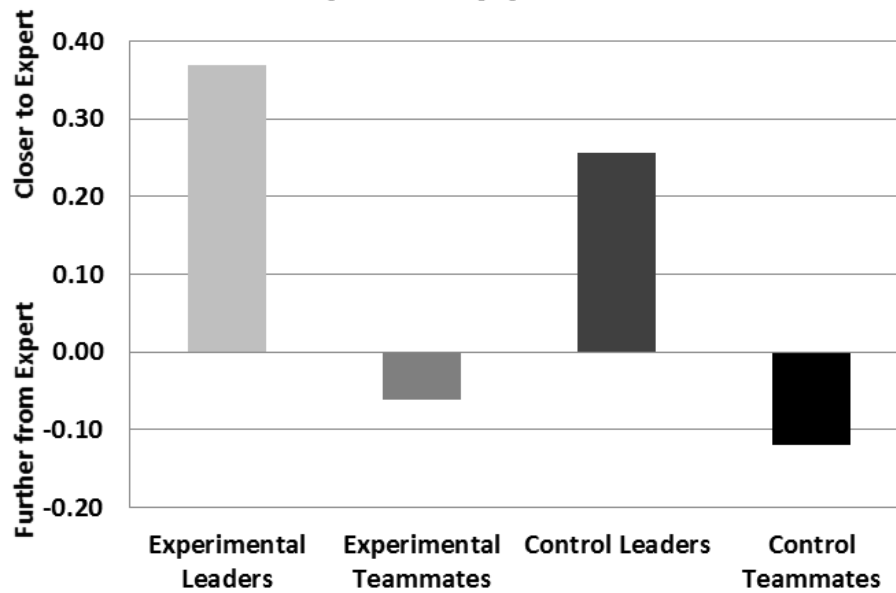
Figure 24. Change in Decision Making Competency as Indicated by SJT Scores.

To determine if the SLTP training could induce stress in Marines, the mean rate of EDR for the experimental group Squad Leaders throughout the five segments of the training were evaluated. STAR-DM leaders showed significant increases in physiological stress response throughout training, with the socio-evaluative stress having the highest impact. As shown in Figure 25, EDR was significantly higher than baseline values (shown as dotted line) throughout all segments of the training ($*p \leq 0.05$)

Figure 25. EDR Average Values for Experimental Leaders at Different Points in the Training.

HRV was also analyzed over the course of the training. Although the temporal domain HRV trended lower during the brief, fire, and debrief segments as compared to baseline, the differences were not statistically significant.
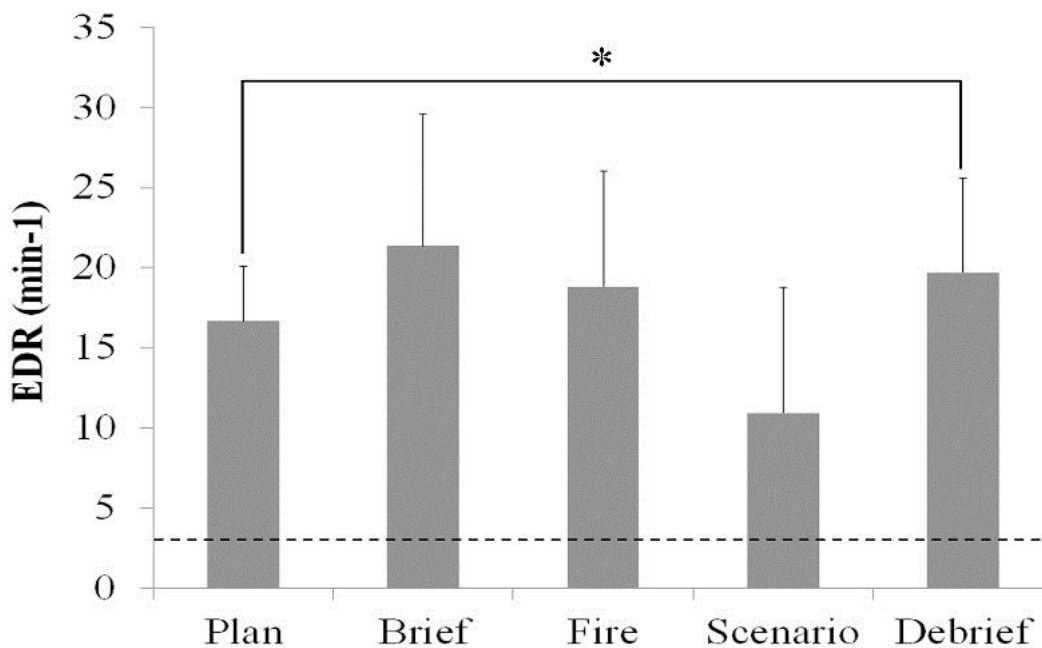
STAI results were also analyzed for both experimental leaders (n = 5) and control leaders (n = 8) to evaluate perceived stress. Results did not show statistically significant effects of condition (experiment vs. control) or trial (baseline vs. post scenario). However, when evaluating the interaction of trial and condition the results are close to achieving statistical significance (F (1, 10) = 4.71; p = .055, η^2 = .32), Figure 26 shows the absolute values of STAI by trial and condition and Figure 27 shows the % change from pre to post-test. These results indicate that the STAR-DM leaders experienced an increase in perceived stress as result of the training whereas the control group did not.
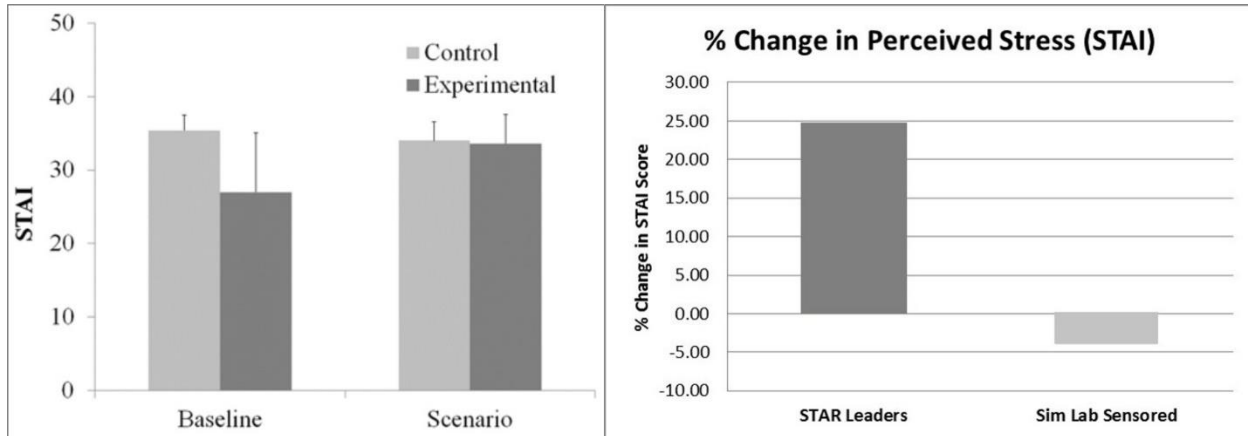

Figure 26: Pre and Post STAI Values by Group, Figure 27: STAI Percent Change

In evaluating if the training effect would transfer to the field, the idea was to compare the expertise level displayed during the field exercises between the control and experimental group. However, due to field study limitations, it turned out that those who served as Squad Leaders during the field exercises were all from the experimental group, thus making that comparison impossible. In lieu of that comparison, the analysis compared performance differences between those who served as Squad Leaders during the training (and therefore were the focus of the training) and those who were teammates, See Figure 28 for results of tactical thinking and adaptability expertise levels by group. Given the small sample size, no statistically significant differences were found between the groups. However, the effect size was moderate indicating that a larger sample size might lead to significance (F (2, 4) = .87, p = .49, η^2 = .30). Based on the sample, results indicate the potential for supporting SLTP training improvements that transfer to the field, in that participants who served as leaders during the SLTP training were assessed at one whole expertise level on average higher than those who were teammates (Competent versus Advanced Beginner).
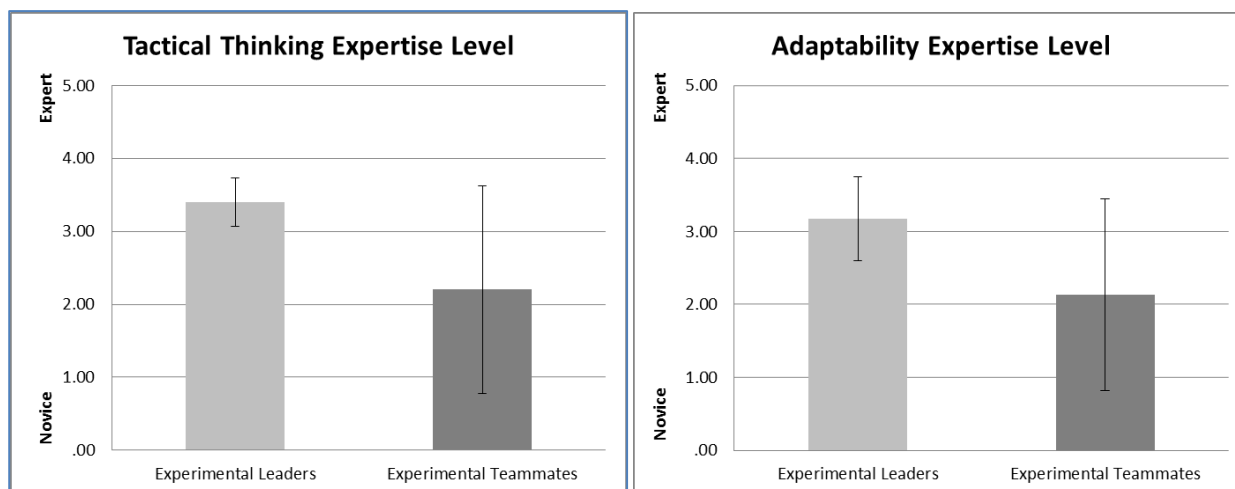
Figure 28. Tactical Thinking and Adaptability Expertise Levels during Transfer Exercise

3.3.3.3 Discussion

Even when utilized in a field setting, specifically during a Marine Corp training course, results show similar promise for the effectiveness of process level feedback in improving DM competency of Squad Leaders. Squad Leaders, who received the process-level feedback, showed the greatest increases in DM competency, although not statistically significantly greater than their control group counterparts. Also supporting the effectiveness of the process feedback-based learning strategy is the increase in expertise level displayed by the experimental group Squad Leaders over their teammates. Ideally, the experimental group Squad Leaders would have been compared against the control group Squad Leaders, but as with many field studies, training requirements had to be prioritized by the instructors over the experimental design of the study. Therefore, only members of the experimental group were able to be assessed in the transfer exercise. Even so, the analysis that was conducted suggests that the process level feedback not only impacted performance and competency levels during and just after training, but that these improvements may transfer to a live environment several days after the training occurred.

Results also provide support for the ability to induce and measure stress in Warfighters during simulation-based training using the STAR-DM approach. The simulation-based training resulted in significant increases in physiological stress response as indicated by EDA levels. Further, when accounting for individual differences in baseline perceived stress, the simulation-based training scenarios led to greater increases in perceived stress as indicated by STAI responses. Interestingly, the training segments which incorporated socio-evaluative stress resulted in the greatest physiological responses. This is a promising result for the military as incorporation of socio-evaluative stress can be accomplished with very few resources because characteristics of its implementation tend to inherently exist in many commonly used military training exercises for Squad Leader training (e.g. judgment of experts while briefing plan, flat affect of experts). Further, the ability to utilize simulation to induce stress, and the ability to capture stress response within Warfighters, provides the military with viable training tools for enhancing decision-making under stress. The capability to identify times when a Warfighter is experiencing increased stress response allows instructors to pinpoint factors contributing to performance decrements (e.g., competent performer, but performance unravels under stress) so as to effectively tailor future training to address each person's individual shortcomings (e.g., needs additional practice performing skills in stressful environment).

Despite significant increases in perceived and physiological stress response in the experimental group, participants rated the training as being of low to moderate stressfulness. This reaction was likely due to the standard against which the training was being compared (e.g. live environments). However, the physiological data provides evidence that the training did induce a degree of stress indicating that self-report measures may not always portray the complete story; more objective measures are needed to fully understand what is actually happening within the Warfighter. To better understand the perceived stress of the simulation-based training compared with theoretically less stressful (e.g. classroom lecture) and more

stressful (e.g. live exercises), future research should administer the STAI after different types of training in the training continuum. This would provide more insight into whether incorporating simulation-based training into the middle of the training continuum does indeed support increasing stress levels throughout the training continuum.

These results must be viewed with caution as there were several limitations of the studies. One limitation was the amount of training time, which was limited due to the amount of time available within the training schedule. Decision making is a complex skill which depends heavily on building up one's experience base, something that is difficult to accomplish within one to two training scenarios. A second limitation with the field study was the lack of control in the study design and execution. As a result, there were several differences between the experimental and control group training, in addition to whether the feedback was process level or outcome feedback. It is not expected that these differences made a huge impact on the results, but it must be noted that they exist. Finally, the field study had a small number of participants, limiting the power of the study.

3.3.3.4 Conclusion

Results suggest, but do not definitively prove, that the STAR-DM simulation training packages:

- Can induce a significant physiological stress response, even in experienced Marines,
- Can improve decision-making performance during training,
- Can improve decision-making performance in stressful field exercises.

3.3.4 TEE

In order to determine if the potential gains demonstrated in the laboratory and field studies would transfer to the real world environment, a training effectiveness evaluation, or TEE, was designed. The original design included a control group and a group that would undergo the STAR-DM SLTP training packages with both the learning strategies and biofeedback tested in Experiment 2 incorporated into their training. Pre and post-test measures would be conducted prior to and after the training. Subsequent to receiving the training, both groups would then conduct a high-stress, live training exercise and their performance during the exercise would be measured and compared to see if improvements could be found in the experimental group.

However, during the course of the STAR-DM program, additional objectives emerged for the culminating event. In addition to wanting to understand the effectiveness of the STAR-DM simulation training packages, it was also desired to evaluate the effectiveness of other training environments. Therefore, the primary research question that emerged was: How does the training effectiveness of the following training environments compare; Classroom training (in the form of TDGs), Simulation training (STAR-DM SLTPs), training on a basic non-instrumented range (such as 62 Area RUF at Camp Pendleton), training on a more-sophisticated, instrumented range (such as Kilo2 at Camp Pendleton), and training at the IIT.

In terms of comparing the five training environments, a prioritized list of study outcomes was developed. The four primary outcomes selected, in prioritized order, were return on training investment (ROTI), training transfer impacts, training impacts, and calculation of the percent of training objectives that can be trained in the given environment. ROTI is an objective method for comparing training value and costs in order to quantify benefit gained through an investment in training. As a primary measure for the TEE, an overall ROTI score for each environment would be determined by aggregating weighted measures of performance, cost and schedule impacts to come up with an "apples to apples" comparison across environments. To determine the impact of the training types on transfer to the real world, the following four items would be evaluated in a hyper-realistic environment: decision-making performance, task performance, stress inoculation, and expertise level displayed during the event. The impact of the training session would be measured by collecting data pre-training and post-training on the following: stress induction, sense of presence, engagement, DM competency, task performance, and expertise level displayed.

The desired participant group for the study was nine Marine Infantry squads. As the Squad Leaders are the focus of the training this would only allow for two Squad Leaders for four conditions and one in one of the conditions which is not ideal. However, due to typical unit sizes, larger numbers of squads were not deemed feasible. The initial design for the TEE is outlined in Figure 29. The first day would include all disclosures and forms per the study protocol as well as collecting baseline, pre-training measures via surveys, SJTs, and physiological sensors. During the second day, participating squads would be split into one of the five training groups and undergo a full day of training. The training in each group would be designed to be as similar as possible, given the training condition, in terms of training objectives and the decision areas being targeted. On the third day the post-training measures would be collected. Then on the last day, participants would complete one or two live exercises in the transfer environment. The preliminary plan for the transfer environment was to conduct a live exercise at Strategic Operations (STOPS) in San Diego, California. STOPS is a military training company that offers hyper-realistic training complete with movie set-like effects and trained role players. The goal of utilizing STOPS for the transfer environment would be to provide an environment as close to real-world combat as possible for evaluating training effectiveness.

Groups	Pre Test (Day 1, 3 hrs)	Training (Day 2, full day)	Post Test (Day 3, 2 hrs)	Transfer (Day 4, full day)
Group 1: IIT	All Trainees: • Pre-training Surveys • Pre-training measures (Situational Judgment Test; SJT, Expertise, Physio)	• 3-4 Scenarios at IIT* • During Training Measures (Perform., Survey, Physio)	All Trainees: • Post-training measures (Surveys, SJT, Expertise)	All Trainees: • Each group will rotate through Strategic Operations and complete the same 1-2 scenarios • Transfer Measures (Performance, Survey, Physio) **Potential to Consolidate days 2 & 3, resulting in 3 day data collection**
Group 2: Kilo2		• 3-4 Scenarios at Kilo2* • During Training Measures (Perform., Survey, Physio)		
Group 3: RUF		• 3-4 Scenarios at RUF* • During Training Measures (Perform., Survey, Physio)		
Group 4: Sim		• 3-4 STAR-DM Scenarios at IIT or Sim lab* • During Training Measures (Perform., Survey, Physio)		
Group 5: Class room		• 3-4 Marine-led Tactical Decision Games* • During Training Measures (Perform., Survey, Physio)		

* All training scenarios will have similar training objectives and decision areas targeted.

Figure 29: Initial TEE Design

Unfortunately, the program team and sponsors, were unable to find a Marine unit capable of supporting the test effort. Many attempts were made over the course of a year and a half to set up the evaluation but none were successful. Given that the significant time requested for the study was one of the difficulties encountered in finding an available unit, the proposed study design was modified and reduced in scope to decrease the time required (see Figure 30). However, the team was still unsuccessful in identifying an available unit to support. Since the culminating evaluation of STAR-DM was unable to be executed, the full training framework proposed in the following section was unable to be evaluated in its entirety, though the pieces of the framework were evaluated separately in the field and laboratory experiments. Thus, while there is evidence to suggest there are multiple benefits to the STAR-DM training approach and the SLTPs, a complete assessment was not possible.

Groups	DAY 1 - Training			DAY 2 - Transfer
	Pre Test (2 hrs.)	Training (4 hrs.)	Post Test (1 hr.)	Transfer (full day)
Group 1 (2 squads): No training	All Trainees: • Pre-training Surveys • Situational Judgment Test (SJT) on computers • Physio - Baseline	• See note	All Trainees: • Post-training Surveys • SJT on computers	All Trainees: • Each group to rotate through IIT and complete the same 2-3 scenarios • Transfer Measures (Performance, Survey, Physio)
Group 2 (2 squads): 62 Area RUF		• 3 Scenarios at RUF* • During Training Measures (Perform., Survey, Physio)		
Group 3 (3 squads): Simulation		• 3 STAR-DM Scenarios at IIT or Sim lab* • During Training Measures (Perform., Survey, Physio)		
Group 4 (2 squads): Classroom		• 3 Marine-led Tactical Decision Games* • During Training Measures (Perform., Survey, Physio)		

Note: The group the does not receive training per the experiment will conduct their transfer scenarios at the IIT on day 1 during the training time and on day 2 they can receive additional training, as desired, in the form of TDGs and/or STAR-DM simulation scenarios

Figure 30. Modified TEE Design to Reduce Time Required

3.4 Final Training Framework

Based on experimental results, a number of alterations were made to the STAR-DM initial conceptual model (section 3.2.5). Due to the difficulty in quantifying OODA-based performance metrics, including real-time metrics, and the absence of a correlation between stress and performance as defined in VBS2 scenarios, a stress-based temporal model of performance was chosen, with real-time stress metrics associated with cardiovascular and electrodermal activity, which was validated in Experiment 1 and a separate Veterans Affairs (VA) randomized controlled trial (Winslow, 2016) as the basis for determining the resilience trajectories individuals undergo during stress (see Figure 31, Norris Soc Sci Med 2009). The following alterations were made to the Norris (2009) model shown in Figure 31 to form the basis of the STAR-DM stress conceptual model:

- Temporal metrics are in the minutes to hours timeframe, rather than the months to years frame,
- Relapsing-remitting and delayed dysfunction trajectories are not included; they were not observed in the STAR-DM studies or the studies performed by Norris, et al.,
- Real-time physiological stress metrics, rather than PTSD scores are utilized as the dependent variable.
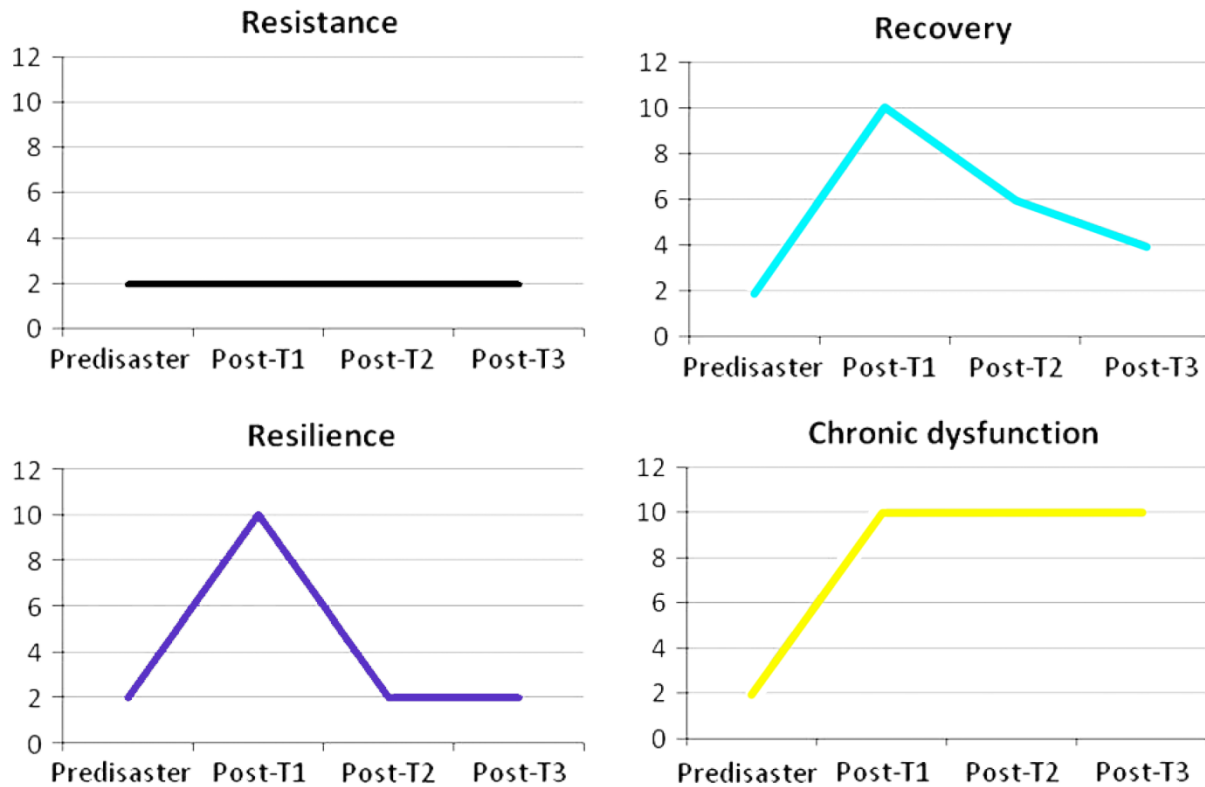
Figure 31: Trajectories Following Exposure to Severe Stress. Norris, Soc Sci Med 2009.

Our data suggests that resilience is best understood and measured as a trajectory, indicative of increased physiological (cardiovascular, electrodermal) activity associated with severe stress, followed by a return to baseline within tens of minutes. Recovery is indicative of increased physiological activity with stress, followed by a reduction after the stressor without returning to baseline, whereas chronic dysfunction is not associated with decreased physiological reactivity following stressor removal. Resistance is defined by no measurable increase in physiological reactivity to stress. All are dependent on an individualized baseline physiological signature.

The purpose of the following sections is to provide guidance on how to utilize simulation to train decision-making under stress. The simulation-based training approach is designed specifically to enhance small unit leader DM skills and the resilience of these skills to stress. There are three key aspects of this methodology including:

- Effective scenario design to ensure that training advances DM skills relevant to target training objectives and can effectively induce stress,
- Integration of objective and quantitative measures of DM performance at the process level and measures of associated stress response,
- Incorporation of learning strategies that have been validated to improve decision-making performance and bolster a trainee's response to stress.

3.4.1 Decision Events

The first step in achieving this is identification of target training objectives. Analysis of training documentation such as the POI or training manuals typically reveals the training goals of the course such as the types of missions and TTPs to be trained. However, in cases in which the documentation does not provide these, additional analysis may be required to effectively identify the training goals (see Milham,

Carroll, Stanney & Becker (2008) for detailed discussion of training needs analysis). For instance, the ISULC POI identifies a set of T&R standards (e.g., lead a squad on a patrol) to be targeted. This provides a framework and scope for the types of decisions to incorporate into the scenarios. The second step is to identify a representative set of relevant decisions. Through course observation (e.g., what are the decisions embedded into training events), training content review (e.g., what are the decision anecdotes, and situations and environments incorporated) and SME interviews (e.g., descriptions of decisions they have made in past deployments and surrounding circumstances and outcomes), a set of relevant and realistic small unit leader decisions that are relevant to the training objectives can be identified. This supports the development of a library of decision types, circumstances, and environments from which to pull scenario decision events and decision factors to embed in the environment. The third step is scenario storyboarding in which a high level mission description (e.g., Area of Operation (AO), type of Military Operation, etc.) is created and scenario decisions are selected and tied together with a realistic and engaging narrative. Each scenario is designed using an event-based methodology (Fowlkes et al., 1998) in which five decision events are incorporated to provide five opportunities for a trainee to practice decision skills as well as five opportunities to assess decision-making at the process levels. Each of the five discrete decision events build upon each other and can have either positive or negative consequences for the participant later in the scenario, based on the quality of the decision that was made. The scenarios are designed such that DM performance impacts mission outcome. Therefore, the more effective the DM performance, the more likely the trainee is to succeed in their mission. These events then act as an outline for the full mission narrative to be created. Working in hand with SMEs, a narrative is interwoven around these events. Each scenario is designed to maximize decision opportunities in a short period of time with situations unfolding very quickly and each scenario taking approximately 15-30 minutes to complete.

3.4.2 Stress Analysis

Contextually-relevant simulation-based stress induction techniques (e.g., dead bodies, artillery fire; see Bouchard et al., 2012) must be integrated to induce stress. Research to date has found that stressors such as seeing dead bodies, receiving artillery or small arms fire, knowing someone is seriously injured or killed are stressful combat experiences that translate into simulation-based stressors because they are frequent, strong psychological challenges that last long enough to be used in narratives (Bouchard, Baus, Bernier, & McCreary, 2010). Key aspects of these stressors which have been shown to impact the level of stress response include unpredictability, novelty and lack of control (Dickerson & Kemeny, 2004). The scenarios incorporate stressors such as these in the narratives to induce varying levels of stress. An attempt is made to vary stress levels induced by the scenarios by varying the number, severity and duration of stressors encountered throughout the scenario (e.g., taking almost continuous gunfire or artillery rounds from various locations out of sight). Based on previous research and the results of the STAR-DM effort, the following is a set of recommendations for incorporating stressors into training for Warfighters:

1. Incorporate socio-evaluative stress. Where possible, incorporate opportunities for an individual to feel he is being judged by a group of experts. Those acting as assessors/judges should attempt to maintain flat affect, maintain eye contact, minimize nodding and provide pointed feedback when possible. This can be done external to training scenarios, or within a virtual environment.
    a. Example(s): During classroom, virtual or live training exercises, require the trainee to publicly (verbally) brief a plan or perform a task. Ensure trainee is aware of performance being judged by expert instructors and peers and provide public and pointed feedback.
2. Incorporate uncontrollability. When designing live or virtual training scenarios, incorporate situations in which any action taken by the trainee does not seem to improve the situation.
    a. Example(s): Provide trainee with faulty weapon or tool which malfunctions when needed, or with little ammunition per clip, such that the trainee must reload often. Incorporate enemies with low vulnerability that are virtually impossible to overcome.
3. Incorporate unpredictability. When designing live or virtual training scenarios, incorporate unexpected situations for which the trainee likely did not have a contingency.

     a. Example(s): Incorporate highly unlikely enemy weapons, capabilities, or tactics. Incorporate situations that could not be anticipated based on the intelligence provided in the mission order, such as the presence of indirect fire after being told that the enemy did not have that capability.
4. Incorporate novelty. When designing live or virtual training scenarios, incorporate situations with which trainees have little to no previous experience.
     a. Example: Incorporate terrain features with which trainees have little experience or give enemies advanced weapons systems that trainees have no experience responding to. Incorporate enemy tactics and Rules of Engagement different than those used in recent AOs.

Each scenario is designed with five events that require some action on the part of the Marine Squad Leader, have clear decision alternatives upon which decision-making can be measured, and are increasing in stress levels based on a stress analysis conducted by the researchers. The following stress analysis example is based on an Experiment 2 scenario titled "Sleight of Hand." The participant is tasked with retrieving explosives from a white van at night. The participant is told before the mission starts not to get too close to any military personnel and to always observe enemies first before taking action. When the participant comes across the van, he finds two military officers near the van. There are also civilians walking around in the marketplace where the van is located.

Step 1 of the stress analysis is to identify all of the potential stressors in the event from a predetermined list. All of the potential stressors are identified under the assumption that the participant correctly executes his tasking during the event. A predefined list of stressors was used for the stress analysis. The stressors applying to this event include:
- Emotional – hazard (e.g. user not briefed that enemy soldiers would be by the van)
- Cognitive – auditory distraction (e.g. the user can hear the civilians talking)
- Cognitive – visual distraction (e.g. the user can see civilians walking around randomly)
- Cognitive – limited visibility (e.g. the user is performing the mission at night time)
- Emotional – tactical patience (e.g. the user must wait for the enemies to leave the area where the van is located)
- Cognitive – workload (e.g. the user must retrieve explosives from the van)

Once all of the stressors are identified, they are rated according to their characteristics. There are five characteristics a stressor can have:
1. Duration (how long the stressor is present during the event)
2. Intensity (how much of a threat the stressor poses to the user)
3. Unpredictability (how well the threat could have been anticipated by the user)
4. Uncontrollability (how much the user can do to remove the stressor from the event within the context of the mission)
5. Novelty (how much familiarity the user has with the stressor)

Points are awarded to each of these characteristics: for example, duration can assume the values of 0, .25, .5, .75, and 1. Unpredictability can be either 0 or 1. Each value for Intensity – Novelty are added up and multiplied by the duration value for each stressor. This yields a total value for an individual stressor, and then the total values for each event stressor are added up to yield an event stress total. The event stress totals are then added up to yield a scenario stress total. The events are designed to increase in stress levels over the course of the scenario.

3.4.3 Assessment

Each scenario incorporates mission performance outcome measures to assess overall performance, such as whether the mission objectives were achieved, time to complete the mission, and number of civilian and friendly casualties resulting. However, to effectively improve an individual's DM performance under stressful conditions, it is necessary to assess decision-making at the process level (i.e., not only decision outcome, but whether the trainee is effectively observing, orienting to the situation, etc.), including the associated stress response in order to understand where and why breakdowns in the decision-making cycle occur. This ultimately allows for remediation to be tailored to the individual.

3.4.3.1 Decision-making Assessment

The framework for assessing DM performance is based on the OODA Loop (Boyd, 1987) which decomposes the decision-making process into four key stages: 1) Observe (collection and integration of sensory information), 2) Orient (interpretation of sensory information to determine the current environment and situation), 3) Decide (evaluation of alternative courses of actions and response selection), and 4) Act (planning and execution of response). Decomposition of the DM process into these four stages allows decision-making to be assessed at the process level in order to understand the root cause of decision breakdowns. So, in addition to typical decision outcome measures of decision effectiveness and time to decide, each stage of the decision process can be assessed independently. For the Observe stage, there are critical AOIs which should be attended to in order to effectively inform a situation. The Squad Leader's observations were inferred from squad communications about AOIs. The Orient and Decide stages are much more challenging to assess as these are for the most part internal and unobservable processes. A combination of two techniques is used to assess these stages of the DM process. First, contextually relevant online queries (Gugerty, 2011; Klein & Hoffman, 1992) in the form of information "pull" from higher command are incorporated into the scenario in which decision makers are prompted to answer questions related to the events unfolding as they perform. These queries are designed to imitate the process of radio communication with higher command so as to minimize interference with task performance. Second, by carefully crafting scenarios designed to elicit certain responses, inference-based measures (Gugerty, 2011) are utilized to infer Orient and Decide stages based on monitoring communications and actions. For instance, in order to assess the Orient stage, at various points throughout the scenario the trainee is asked to verbally report what they see and what it means. Based on the percentage of critical situation factors reported, orientation effectiveness level is assessed. In order to assess the Decide stage, the trainee is asked to verbally report the possible courses of action they can take. Based on the courses of action reported and the actions taken, the effectiveness of the decide stage is assessed. The Action phase is assessed based on how effectively the response is carried out; however, Action is not a major focus of this effort as it is typically an indication of tactical/technical skills, not decision effectiveness. These measures facilitate the assessment of each stage independently and provide granularity in assessment to understand where breakdowns in the DM process originated and identify patterns of these breakdowns across decisions (e.g., does a performer have issues with situation assessment that need to be remediated).

3.4.3.2 Stress Assessment

Stress can impair the DM process leading to reductions in quality of and confidence in decisions (for review of impacts of stress on decision-making see Carroll et al., 2012). Assessment of an individual's stress response during DM performance can assist in determining if performance decrements are due to basic skill deficiencies or failure of the skill to be resilient to stress, and therefore inform how to remediate performance decrements. Additionally, real-time monitoring of stress can be used to provide biofeedback to trainees which was shown to be effective in helping them moderate their stress levels resulting in improved performance in Experiment 2. Stress response can be objectively and quantitatively assessed, in near real time, without disruption to task performance by utilizing physiological measures. When an individual encounters a significant stressor, the sympathetic or "fight or flight" division of the autonomic nervous system increases in activity, resulting in hormone release and subsequent physiological effects on multiple organ systems. Among a myriad of effects, heart rate increases, pupils dilate, blood vessels constrict, and sweat glands become active.

Existing approaches to stress detection use a wide array of features calculated from sensor data measuring various aspects of heartbeat including include PPG or ECG (Sun, Kuo et al. 2010; De Santos, Sánchez-Avila et al. 2011; Plarre, Raij et al. 2011), skin conductance measurement (Bakker, Pechenizkiy et al. 2011; Alamudun, Choi et al. 2012; Choi, Ahmed et al. 2012), and measurement of respiration, all of which are responsive to increased sympathetic nervous system activity associated with stress (Everly and Lating 2002). Standard supervised machine learning methods have been used previously to develop stress classifiers, which require subjects to engage in tasks known to induce stress so that stress or non-stress labels can be assigned to the input features. Previous work has emphasized the difficulties imposed on stress classification by individual subject variability in physiological responses to stress (De Santos, Sánchez-Avila et al. 2011; Alamudun, Choi et al. 2012). Another concern is the physical activity

of subjects, which triggers similar cardiovascular and electrodermal physiological signals as stress, leading to masking and confounds of stress detection (Sun, Kuo et al. 2010; Alamudun, Choi et al. 2012). The major challenge in using mobile physiological sensors to quantify stress is the lack of robust and clinically tested algorithms to classify stress in a mobile environment in real time (Martínez-Pérez, de la Torre-Díez et al. 2013). Previous stress monitoring algorithms have been built with traditional laboratory physiological sensor suites that do not translate well to operational settings (Plarre, Raij et al. 2011; Alamudun, Choi et al. 2012). New wearable devices with clinical grade sensors such as the Empatica E4 which sends PPG, EDA, temperature and accelerometry data via Bluetooth LE and associated algorithms such as the Operational Stress Index (OSI; Dechmerowski et al., 2014) have the potential to take real-time stress monitoring outside of the laboratory. The capability of assessing physiological metrics associated with stress reactivity, such as cardiovascular and electrodermal activity, in context via sensor-based assessment of movement and temperature, along with algorithm personalization via individual baselining, allows for high accuracy stress classification in an ambulatory environment. Continuing work with the Department of Homeland Security (DHS) is focusing on expanding the sensor technology used to assess stress, including MC10's BioStamp RC, and Physical Optics Corporation's (POC) MVSS sensor suite, in development for the Air Force Research Laboratory. Additional work with DHS is focused on developing a visualization tool to view multiple trainee's stress state in real time, and refining the classifier to function in extreme environments, such as exposure to high temperatures and humidity.

3.4.4 Incorporated Learning Strategies

There are innumerable learning strategies which have been explored in the laboratory and the field and have shown varying degrees of success at effectively training decision-making and/or stress skills (e.g., Klein, 1993; Lipshitz, Klein, Orasanu, Salas, 2001; Batha & Carroll 2007; Calderon & Thompson, 2004). Pre-training exercises, such as planning exercises which require trainees to identify and layout the plan for how they will accomplish a goal have been effectively utilized (Blackburn et al., 2004). A key learning strategy which can be utilized during training is an Event-Based Approach to Training (EBAT; Fowlkes et al., 1998) in which training opportunities are systematically created by presenting events designed to elicit specific skills or behaviors (e.g., decision-making). EBAT has been shown effective at training DM skills across a range of domains (Fowlkes et al., 1998). After action review techniques such as error-based or causal-based feedback (Carroll et al., 2008, Carroll, 2010) provide the opportunity to target decision-making at the process level. Errors are considered to be valuable opportunities to clarify misunderstandings in learners (Mory, 2004) and the identification of underlying causes of deficient processes allows instructors to provide meaningful feedback to correct these deficiencies (Salas et al., 2007). This can be combined with specific learning strategies such as attribute isolation in which central attributes of target concepts (e.g., why cues are critical for a situation or indicative of an impending threat) are highlighted to improve general understanding of phenomenon (Mason & Bruning, 2001).

There are also multiple learning strategies that can be used to target an individual's stress response during decision-making training. Biofeedback is a process by which individuals learn to control certain autonomic nervous system functions such as blood pressure, salivation, sweat gland activity, and cardiac activity through feedback signals from sensors monitoring physiological responses (Calderon & Thompson, 2004). BioFeedback Training (BFT) techniques typically encompass three stages wherein a trainee 1) acquires awareness of maladaptive physiological responses, 2) learns to control the response utilizing techniques such as deep breathing and muscle relaxation and 3) learns to transfer this control to everyday life (Lehrer & Wolfolk, 1993). As shown in Experiment 2, the use of biofeedback led to reduced stress levels and potential performance increases. Stress exposure strategies such as Stress Inoculation Training (SIT; Saunders et al., 1996) and Stress Exposure Training (SET; Driskell and Johnston, 1998) also incorporate three phases, except in this case they involve 1) an education phase to help the trainee better understand the nature of stress and stress effects, 2) a skill acquisition and rehearsal phase to facilitate development and practice a repertoire of coping skills and 3) an application phase in which coping skills are applied in conditions that increasingly approximate the transfer environment. Both techniques have been shown effective in increasing a trainee's ability to cope with stress (Sheehy & Horan, 2004; Saunders, Driskell, Hall, & Salas, 1996; Meichenbaum & Deffenbacher, 1988). Metacognition strategies can be utilized to facilitate awareness of how one perceives and thinks about stressors as well as an accurate appraisal of a stressor by assessing best, worst, and most likely

outcomes (Narayanan, 2009). Further, metacognitive strategies can also be utilized to increase awareness of the detrimental impact the stressor is having on an individual's DM process (e.g., narrowing the perceptive field).

3.5 Integrated Simulation-based Training Approach

The above presented learning strategies are all feasible to implement in a military schoolhouse setting. However, the challenge remains how to seamlessly integrate the strategies into current training curriculum in an easy-to-use simulation-based approach. To achieve this, the "Do Something" instructional approach was utilized (DeVore, 2010). The "Do Something" approach is a concise instructional method that incorporates four components in which 1) the mission is presented via a video narrative, 2) the trainee is given a brief period to create and brief their plan, 3) the plan is executed in a simulation-based scenario and 4) an instructor and peer-based after action review is conducted utilizing a series of tools (e.g., performance replay). This approach provides a framework for anchoring the pre, during and post training strategies referenced above into a simulation based training package.

First, a video narrative presents the orientation, situation, mission objective and tactical dilemma. The video provides an outline of the mission goals and cues the trainees to critical factors to which they should attend (Advance Organizer). This is delivered in a realistic and immersive video designed to increase engagement and motivation (Motivation Strategy).

Second, the trainee performs a planning exercise in which they analyze the situation, devise a mission plan and develop and deliver orders to their team. The instructor then alerts the trainee of an incorrect situation assessment or failure point of the plan (Crystal Ball, Premortem Exercise). The trainee must re-plan and re-issue tasks to the team. This is conducted under time constraints and in the presence of unit leadership to induce stress. This is a form of social-evaluative stress, which can be induced when others negatively judge ones performance and has been found to elicit significant and reliable physiological stress responses (Dickerson & Kemeny, 2004). During the training, the trainee is equipped with a limited set of invasive physiological sensors (e.g., heart rate, EDA) whose output is displayed for the instructor and trainee to see (BioFeedback). As the plan is briefed, the instructor can point out to the trainee times their physiological state is elevated, the resulting physiological response (e.g., HR increase, sweat present, tense shoulders) and present one or two quick and easy coping strategies to reduce stress response (i.e., deep breathing, muscle relaxation) which the trainee can practice and is then encouraged to employ at any time during the training when they recognize the physiological response to stress they just learned about.

Third, after the plan has been briefed, the trainee leads his team through the execution of the plan in a simulation-based scenario designed to elicit adaptive decision-making skills under stress. The trainee encounters five decision events as he performs the mission, requiring him to effectively observe, orient, decide and act (event-based training) while process level DM performance is assessed via measures discussed above. During scenario execution, the trainee experiences a series of simulation-based stressors such as limited visual perception (night missions), sudden noise exposure, equipment failures, and receiving enemy fire, as well as cognitive stressors (e.g., time pressure) and emotion induction procedures (e.g., dead combatants, soldiers and civilians). The scenarios are high fidelity, include a variety of novel, unexpected challenges and increase in complexity as training progresses.

Fourth, an AAR is conducted utilizing a series of tools. While mission outcome performance is briefly reviewed, the AAR focuses on the process level DM performance metrics, emphasizing the root cause of decision breakdowns which propagated to mission failure (e.g., consistent failure to detect critical cues; mastery orientation, error-based, causal-based feedback). For errors identified, central attributes of target concepts (e.g., why decision alternative selected was a poor choice) are highlighted to improve decision skills (attribute isolation).

4.0 Squad Leader Training Packages (SLTPs)

The training packages are comprised of the following components:

(1) Multimedia Videos. VBS2-based Road to War and Operational Update videos detail the situation and environment and are designed to engage and motivate the trainees.

(2) Mission Orders/ Fragmentary Orders (FRAGOs). Paper-based and/or video-based mission orders/FRAGOs are included for delivery by the instructor/facilitator for viewing by the trainees. After receiving mission orders, the packages are designed to allow the Squad Leader to plan the mission and task fire teams based on these orders. There are guidelines provided to make this a more stressful experience, such as time pressure and instructor maintaining eye contact and providing pointed feedback.

(3) VBS2 Scenarios. Each package contains four VBS2 scenarios designed to allow the entire squad to execute the Squad Leader's plan in a networked VBS2 simulation. As the team performs the scenario, they encounter five discrete decision events in which the Squad Leader has to determine the best course of action and/or adapt his plan.

(4) Measurement and Debrief Tools. The packages have integrated paper-based assessment tools that allow instructors to assess performance at the process level. The assessment tools are designed to also facilitate a DM focused debrief.

(5) Instructor Preparation Guides. Each package is accompanied by an IPG, which walks an instructor step-by-step through delivery of the training packages.

Detailed descriptions of each of the four SLTPs are provided in the following sections.

4.1 SLTP 1 – Genocide Intervention

A drug kingpin named Sanchi Abacca has fabricated a small army in central Africa known as the African Revolutionary Melee (ARM). His goal is to kill all people who impede the future economic growth of Africa. The 26th Marine Expeditionary Unit has been ordered to conduct operations to disrupt the ARM activities, because it is feared that any delay will give the ARM an opportunity to employ weapons of mass destruction.

4.1.1 Scenario 1 - Maritime Assault

This scenario will challenge the squad to correctly prioritize enemy boats in an ambush. After the ambush, the squad will have to effectively combat foot mobiles, mortar attacks and enemy snipers. This scenario addresses the following T&R Objectives: 0311-OFF-2002, INF-MAN-4301, and INF-MAN-4002. Table 9 displays the events contained in the Maritime Assault scenario.

Table 9. Maritime Assault Scenario Events

Event	Event Title	Stimuli	Decision Alternatives
1	Woman Screaming	Marines begin movement from insert landing zone (LZ) towards ambush position and they hear women screams and gunshots about 300-400 m north of their position.	• Send full squad to investigate • Send part of squad to investigate • Have full squad continue to ambush position

2	Static Enemy Technical	Marines are continuing and spot an enemy jeep as they are approaching the river with 2 ARM soldiers in it (soldiers' backs are to the Marines).	• Squad on line, assault through enemy forces • Coordinate maneuver with minimal Marine shooters and minimal force required • Bypass the jeep (in which case, soldiers will attack Marines as soon as they go around them)
3	Enemy Watercrafts	Marines have set into their ambush position, and then 3 boats of various sizes appear on the expected route with 5-6 uniformed enemies per boat. All 3 boats have large weapon systems on them, but one boat is larger with communication equipment also.	• Prioritize the larger communications boat as highest priority • Prioritize the lead boat as the highest priority • Make the boats equal priority
4	Enemy Squad	About 2-4 minutes after ambush is over (either all boats are destroyed or any of the boats get away), a squad-sized enemy unit will move in from the West.	• Stand their ground and fight enemy squad • Egress • Marines attempt to detach a fire team in order to establish an L-shaped attack (i.e. flanking enfilade)
5	Sniper/Mortar Attack	When Marines are about 200 m from the town, 2-3 mortars impact near them, then about 30 sec later 2 enemy snipers will begin engaging the Marines from 2 separate shooting positions. An enemy technical vehicle will appear from the East and engage.	• Engage sniper(s) • Engage the technical vehicle • Execute bounding maneuver towards the tree line (to the rear) while suppressing technical • Mask movement with smoke and egress

4.1.2 Scenario 2 - Cutting Off an Enemy Assault

This scenario will have the squad waiting to ambush an enemy convoy with a combination of indirect and direct fire. They will observe several groups that do not match the enemy description, and they will be forced to make shoot/no-shoot decisions. Finally the target enemy group will appear, and the squad is expected to engage them appropriately. This scenario addresses the following T&R Objectives: 0311-DEF-2002, INF-MAN-4002. Table 10 displays the events contained in the Cutting Off an Enemy Assault scenario.

Table 10. Cutting Off an Enemy Assault Scenario Events

Event	Event Title	Stimuli	Decision Alternatives
1	10 Civilians	10 civilians (3 with weapons) run past the hill from E to W	• Order Squad to engage • Utilize indirect fire • Identify the group as civilians and let them go
2	Civilian Vehicles	2 civilian vehicles begin driving towards Marines' position past one on-call target location	• Use squad's weapons to shoot at vehicles • Use indirect fire to shoot at vehicles • Identify the vehicles as civilian and monitor them from their position

3	2 Enemy Technicals	2 enemy technical vehicles will come from the NE, along the enemy's expected path	• Use indirect fire to shoot vehicles • Use squad's weapons to shoot vehicles • Allow the vehicles to go through and see what they do or allow the rest of Alpha Company to deal with them
4	3 Squad Foot Mobiles	3 squads of foot mobile enemies come down the expected path from the NE	• Initiate contact with indirect fire asset followed by squad's weapons • Initiate contact with squad's weapons using indirect fire asset as defensive measure • Only use squad's weapons against the enemy element • Call for fire and egress • Displace squad
5	6 Technical Vehicles	6 technical vehicles come down the expected path from the NE	• Immediately break contact to get cover and concealment • Hold off enemy until they can utilize another indirect fire attack • Use indirect fire to suppress while they break contact and get cover and concealment

4.1.3 Scenario 3 - Attacking an ARM Compound

This scenario will have the squad attacking an ARM compound to perform Tactical Site Exploitation (TSE). The squad will face a variety of foot-mobile and vehicle-borne enemies. This scenario addresses the following T&R Objectives: 0311-DEF-2002, INF-INT-4001, INF-MAN-6004, and INF-FSPT-4001. Table 11 displays the events contained in the Attacking an ARM Compound scenario.

Table 11. Attacking an ARM Compound Scenario Events

Event	Event Title	Stimuli	Decision Alternatives
1	Civilian & Guard Patrol	Squad is approaching compound and a 2-man ARM patrol with a civilian prisoner walks by in their field of view approximately 200 m from the compound.	• Shoot the ARM soldiers or take cover • Watch where they go and try to conduct pattern analysis • Attempt to circumvent ARM soldiers
2	Death Squad	5-ton arrives at the front gate of the compound with 2 ARM soldiers and 5 civilians. Civilians line up against the wall and one of the soldiers begins loading his weapon.	• Attack ARM soldiers before they can execute civilians • Attack soldiers immediately after they execute the civilians • Remain covered and continue with planned attack
3	2 Enemy Technicals	Sporadic gunfire is heard off in the distance. 2 enemy technical vehicles will be passing by behind the Marines about 200 m away and go static. After 30 sec they will drive to the compound.	• Engage the vehicles while they are moving toward the static position • Wait to see what happens and then engage them within 30 seconds after they are static • Attempt to engage them once they start moving towards the compound
4	15 ARM Soldiers in Tree Line	After TSE, 15 ARM soldiers will come in from the tree line armed with RPGs and medium machineguns	• Bound and break contact • Stay and fight

5	BMP at LZ	Marines see a BMP about 500 m from their location and about 350 m from the LZ. After 3 minutes of static behavior, the ZSU-23-4 will begin to move towards Marines and engage them.	• Call for extraction for the secondary LZ • Call for extraction for the primary LZ

4.1.4 Scenario 4 - Evacuation

This scenario will have the squad facilitating an evacuation of civilians. They will witness a friendly helicopter crash, and have to decide how best to help the surviving pilots defend themselves against enemy foot mobiles. This scenario addresses the following T&R Objectives: 0300-PAT-1009 and INF-MAN-4301. Table 12 displays the events contained in the Evacuation scenario.

Table 12. Evacuation Events

Event	Event Title	Stimuli	Decision Alternatives
1	Abandoned Technical	Squad finds an enemy vehicle with a heavy machinegun. The vehicle has broken down and there are 2 dead enemies on the ground next to it, but the weapon still has ammunition.	• Have someone on the squad mount the enemy machinegun and use it • Do not have anyone mount it
2	Civilians	8 civilians (2 are armed, all male) come running from the tree line into the sector of the squad towards the town	• Shoot them • Do not shoot them
3	Helo Crash	A helo crashes in front them about 1000 m away	• Send all or part of squad to check for survivors • Call Higher; request guidance
4	Mortar Brackets	1 illum round goes off. 1 mortar hits 200 m in front of squad. 1 mortar round hits 100 m behind the squad. 1 mortar round lands 5 m from the enemy vehicle. 1 large explosion and several smaller explosions occur about 600 m in front of them in the tree line & remnants of the mortar section that fired upon them are visible.	• Move the squad out of the current fighting position (more than 100 m away) • Keep them in relatively the same position (within 100 m)
5	Friendly Fire Fight	Marines will hear both M-16 and AK-47 weapons engaging in a firefight, implying that the fight is friendly vs. enemy. Initially Marines will only be able to see some tracer rounds in addition to hearing the weapons. The friendly pilot crew will ascend up the hill towards the Marines. Enemy tracer rounds will be impacting around the pilot crew. Some enemies will become visible at the cusp of the tree line.	• Suppress the enemies over the head of the pilot crew • Move the squad to a position where they can suppress the enemy without firing over the heads of the pilot crew • Do not suppress the enemy to avoid shooting over the heads of the pilot crew

4.2 SLTP 2 - Interior Collapse

In the fictitious country of Sahrani, a civil war is raging. One side, the People's Sahrani Army (PSA) has made threats towards the US and other neighboring countries if they intervene in Sahrani's domestic dispute. The US has sided with the PSA's opposition, the Cortez Parliamentary Party (CPP) due to their attitudes toward preserving international tourism in the country and their measured and logical approach to the mining of Promethium, an element that can be used in the creation of nuclear weapons. The Marines of the 22nd Marine Expeditionary Unit are being deployed to support the CPP.

4.2.1 - Amphibious Assault

This scenario will challenge the squad to clear a town and gain control of a prominent hill in the area. The squad will face multiple types of adversaries (e.g. foot mobiles, snipers, technicals, and full 5-tons). This scenario addresses the following T&R Objective: INF-MAN-4001. Table 13 displays the events contained in the Amphibious Assault scenario.

Table 13. Amphibious Assault Events

Event	Event Title	Stimuli	Decision Alternatives
1	Beach Explosions	Marines start dismounted from the Amphibious Assault Vehicle (AAV). After squad has moved about halfway between AAV and town, they will hear and see explosions west of their objective (Parato).	• Disperse • Stay together • Stay together; Update Higher
2	Civilians Murdered by Enemies	As Marines approach Parato, a small group of civilians (5-6) attempt to flee the town. Gunshots are heard as the civilians flee on foot & some civilians are shot and killed. As the Marines continue their movement, they will see 2 enemies flee towards the east.	• Engage enemy while remaining static (pursue by fire) • Engage while pursuing enemy • Do not shoot enemy at all
3	Civilian Car	Civilian car comes speeding towards Marines from direction in which enemy uniformed personnel just ran. At the same time, gun shots are heard to the north (left) of the squad.	• Engage vehicle • Not engage vehicle
4	Enemy Snipers	As the Marines approach the LOA, a six man sniper team will open fire on the Marines from the top of the hill.	• Ignore sniper while they continue clearing town • Stop clearing the town, go firm, report to higher, prosecute afterwards • Split up with part of squad going after sniper and part of squad finish clearing town
5	Sniper/Mortar Attack	Once the Marines have obtained the hill position, enemy reinforcements will begin to appear from the north in the form of an enemy 5-ton vehicle deploying a squad and two enemy technicals providing support by fire for the advancing enemy squad.	• Consolidate all Marines to single linear firing position. • Spread fire teams out and protect by fire. • Break contact.

4.2.2 - Helo Raid

This scenario will have the squad infiltrating an enemy compound to destroy key radar equipment. The squad will face decisions about whether or not to remain concealed and undetected and when to destroy the targets. This scenario addresses the following T&R Objectives: 0311-OFF-2003 and INF-ASLT-3006. Table 14 displays the events contained in the Helo Raid scenario.

Table 14. Helo Raid Events

Event	Event Title	Stimuli	Decision Alternatives
1	Illum Round	After a few minutes of movement towards the objective compound, an air illumination round goes off near squad.	• Stop and wait for illumination round to dissipate • Continue moving toward their objective
2	Civilian Man	As Marines continue their approach toward the objective, a random civilian appears and walks by near the squad.	• Shoot the civilian • Continue movement ignoring civilian's presence • Wait and hide until the civilian passes
3	Civilian Execution	Civilian pickup truck approaches from the north and stops between the Marines and their objective. The Marines will witness two uniformed enemy dismount the vehicle with a civilian. One of the enemy soldiers will execute the civilian.	• Hide and wait until vehicle leaves • Prosecute the uniformed guys (resulting in increased enemies, actively searching) • Try to circumvent the vehicle
4	Radar Equipment	Marines make it to the compound and begin searching for the equipment. In the north portion of the compound they will find 2 (or 4) OPFOR with weapons guarding the equipment. There will also be dead civilians around the equipment.	• Set off charge immediately (potentially compromising the squad's position when you still need to move to the extraction point) • Set off charge right before getting on the extraction helo (risking the helo on deck)
5	Technical Vehicles	Technical vehicle with 4 enemies (and additional troop carrier with 4 additional uniformed personnel if squad engaged enemies in Event 3) stops on road on the east side of compound.	• Stand their ground and engage enemy OPFOR • Break contact and move directly to LZ

4.2.3 - Initial Tactical Recovery of Aircraft and Personnel (TRAP) Effort

This scenario will have the squad performing a TRAP mission to rescue downed helicopter pilots. They will face many obstacles such as snipers, mortar fire, enemy helicopters, and armored vehicles. This scenario addresses the following T&R Objective: INF-MAN-4209. Table 15 displays the events contained in the Initial TRAP Effort scenario.

Table 15. Initial TRAP Effort Events

Event	Event Title	Stimuli	Decision Alternatives
1	Civilian Truck	Squad begins moving toward crash site. A few minutes later, a civilian truck from the southwest deviates from the road, passes the Marines, and begins speeding toward the crash site.	• Let the vehicle go and see what happens • Attempt to disable the vehicle (e.g. shoot out tires) • Kill the driver

2	Sniper Fire	As the Marines continue to approach the downed helo, a sniper will begin firing on them while they are most likely in a relatively open area.	• Have the squad take cover and communicate to determine location of the sniper before shooting him • Immediately suppress the suspected direction of the sniper
3	Mortar Fire	After Marines cross a certain point closer to the helo, they will begin to take mortar fire from unknown point of origin (POO), and will also hear gun shots in the distance.	• Increase dispersion and move out of intended kill zone • Take cover immediately and tuck into position until mortar fire ends
4	Russian Hind	Once the Marine squad is approximately 200 meters away from the downed helo, an enemy helo comes up comes from their east, flying towards the crash site and they still hear bullets nearby. It appears to not be aware of the Marines' presence.	• Employ machineguns/ Shoulder-Launched Multipurpose Assault Weapon (SMAW) to try to shoot down the helo (helo becomes aggressive) • Remain concealed while it passes by
5	Enemy T-72	Just after the Marines arrive at downed helo and begin executing their plan to provide security and assess the number of casualties, they will hear and see an enemy T-72 roll in from the east of their location at about 400 south-east, ultimately coming to a halt in an open area. They will still be hearing bullets flying nearby and there will be dead friendlies around the helo.	• Stay near the helo to provide security and prosecute the tank • Move to a position where the squad has more cover and concealment to prosecute the tank • Attempt to split the squad to conduct both actions simultaneously

4.2.4 - Night Ambush

This scenario will have the squad conducting an ambush at night. The squad will have many shoot/no shoot decisions, until the target finally arrives. This scenario addresses the following T&R Objectives: INF-MAN-4002 and 0300-PAT-1009. Table 16 displays the events contained in the Night Ambush scenario.

Table 16. Night Ambush Events

Event	Event Title	Stimuli	Decision Alternatives
1	2 Civilian Vehicles	The squad will have about 5 minutes to move to and set in to ambush position. At this point, 2 civilian vehicles drive down the Main Supply Route (MSR) in front of them.	• Shoot (Marines detected) • Not shoot
2	5 Civilian Vehicles	About five minutes after the civilian vehicles move through, 5-6 civilian vehicles drive down the MSR in front of the Marines.	• Shoot (Marines detected) • Not shoot

3	2 Enemy Vehicles	About five minutes after the second set of civilian vehicles move through, two enemy technical vehicles drive down the MSR in front of the Marines. There will also be an alarm going off in the distance and a civilian runs out of the building next to the MSR and runs across the road.	• Shoot (Marines detected) • Not shoot
4	Dismounted Enemies	About five minutes after the technical vehicles move through, 6 dismounted enemies walk parallel with the NE/SW running MSR.	• Shoot • Not shoot (Once the enemies have passed the projected left lateral limit (LLL) of the Marines' ambush position, mortar illumination will appear above the dismounts, and a notional, adjacent friendly unit will prosecute the dismounts.)
5	6 Enemy Vehicle Targets	About five minutes after the enemy dismounts are taken out by the adjacent friendly unit, 6 enemy vehicles come down MSR.	• Shoot • Not shoot

4.3 SLTP 3 - Allah's Purge

A small Islamic-based terrorist group named Al-Sharia has been impeding the UN's efforts to provide aid to the fictitious country of Hakabaa to manage an Ebola outbreak. Al-Sharia claims the outbreak is part of Allah's will to eradicate the infidels. The Marines of the 24th Marine Expeditionary Unit have been tasked with the neutralization of the Al-Sharia group in order to help foster the quarantine and aid the UN medical-staff.

4.3.1 - Locate and Secure Dr. Platt

This scenario will challenge the squad and the Squad Leader to conduct a raid and deal with an immediate threat (a sniper). After they are unable to secure the Person of Interest (POI) (Dr. Amil Platt), the squad takes sniper fire. The squad will have to identify and neutralize the threat. Once higher directs them back to the starting location, an enemy force approaches from the south to reinforce enemy units within the village. This scenario addresses the following T&R Objectives: INF-MAN-4209. Table 17 displays the events contained in the Locate and Secure Dr. Platt scenario.

Table 17. Locate and Secure Dr. Platt Events

Event	Event Title	Stimuli	Decision Alternatives
1	Empty Target House	The house is empty. Squad finds signs of struggle and overturned furniture.	• Radio current sit to higher, suggest interacting w/ populace • Radio current sit to higher • Perform extraction w/o radioing higher
2	Squad Encounters Boy w/ Intel	Squad engages in conversation with a local village boy that informs the Squad Leader that bad men took Dr. Platt to the north end of the city.	• Report to higher • Order the squad to head to compound on north end of city • Order team to set up over-watch

3	Black SUV Drives Away	As Marines near the compound, a black SUV drives in front of their view heading west.	• Request intelligence, surveillance, and reconnaissance (ISR) to follow SUV • Open fire on the SUV
4	Sniper Fire	A sniper near the middle of the city begins to engage the squad.	• Pursue sniper by fire • Orient overwatch to sniper position • Take cover and pop smoke
5	Contact from MGs & Technical	The squad is directed by higher to check house for intel. As they approach the house, they are engaged from the south by 1 technical truck and 4 machine gunners.	• Keep the squad together to neutralize the enemy before searching for intel • Split the squad before all enemies are neutralized to look for intel • Break contact, fall back, and discontinue the search for intel

4.3.2 - Clear an Enemy Roadblock

This scenario will have the squad attempting to clear a road block that the enemy has constructed to deny friendly forces freedom of movement. The scenario will escalate as enemy forces begin firing at the squad as they attempt to clear the roadblock. After the roadblock is cleared, a large enemy force will engage the squad's breaching element from the west. This scenario addresses the following T&R Objective: INF-MAN-3202 and INF-MAN-4204. Table 18 displays the events contained in the Clear an Enemy Roadblock scenario.

Table 18. Clear an Enemy Roadblock Events

Event	Event Title	Stimuli	Decision Alternatives
1	Orange Truck	As the roadblock comes into the squad's view, an orange dump truck drives away from the trash pile.	• Do not engage the vehicle; observe. • Report the truck to higher. • Engage the vehicle.
2	Civilians Run from Trash Pile	The squad sees several civilians flee from the trash pile as the squad nears.	• Observe civilians • Report sit to higher • Engage civilians
3	Light Fire from Enemy	As Marines approach the roadblock, they receive light enemy fire.	• Return fire, suppress enemy, then send Marines to set charge • Return fire and simultaneously set charge • Move to set charge while receiving fire
4	Heavy Fire During Charge Placement	An enemy machine gun team attacks the breaching element as they are placing the charge	• Take cover and return fire while talking the Support by Fire (SBF) on to enemy position • Have breaching element return fire as main effort • Return fire in an uncoordinated effort
5	Reinforcements	After the roadblock has been breached, the breaching element will receive heavy fire from the west.	• Suppress with SBF and have breaching element withdraw • Suppress with SBF and hold breaching element in place • Only have breaching element hold position

4.3.3 - Support Third Squad

This scenario will have the squad supporting a pin downed 3rd squad. This will require the Squad Leader to be mindful of the squad's effective weapon ranges and appropriately integrate fires. This scenario

addresses the following T&R Objective: INF-MGUN-4001. Table 19 displays the events contained in the Support Third Squad scenario.

Table 19. Support Third Squad Events

Event	Event Title	Stimuli	Decision Alternatives
1	3rd squad pinned	3rd squad reports that it is taking heavy enemy fire and needs immediate support.	• Emplace machine gun (MG) team to provide supporting fires while rest of squad maneuvers on to enemy • Provide supporting fire with entire squad regardless of distance • Maneuver to close on enemy before providing supportive fires
2	Civilians in field of fire	Civilians begin to run in a zig-zag pattern in a valley below the squad's ideal MG position	• Hold and shift fires accordingly to avoid civilians • Continue suppressing regardless of civilian positions • Engage the civilians
3	Technical vehicles fire at squad	Two technical vehicles adjacent to the enemy squad begin descending down the hill towards the squad.	• Request fire support on technical position • Prioritize technicals with MGs • Engage technicals with entire squad
4	Near threat fire team	Midway between the squad and the enemy force, a fire team begins making their way up to the squad to attack.	• Engage fire team with light MGs while utilizing heavy MGs for technical or 3rd squad enemies • Engage fire team with heavy MGs
5	Enemy technical from west	After all enemies are neutralized, an enemy technical attacks the squad from the rear.	• Engage enemy with all organic assets • Call for danger close fires • Break contact and withdraw

4.3.4 - Ambush Enemy Reinforcements

This scenario will have the squad conducting an ambush on an enemy force. Environmental conditions and enemy activity will force the Squad Leader to make tactical ambush-preparation decisions. This scenario addresses the following T&R Objective: INF-MAN-4002. Table 20 displays the events contained in the Ambush Enemy Reinforcements scenario.

Table 20. Ambush Enemy Reinforcements Events

Event	Event Title	Stimuli	Decision Alternatives
1	Fence line prohibiting movement	While moving to the ambush position, the squad comes across a fence line with two breaks in it. One of the breaks is out in the open and one is covered by trees.	• Cut through fence • Pass through break in fence that is further but better concealed • Pass through break in fence that is closer but offers no cover or concealment
2	Fog & rain set in	As the squad settles in to their ambush position, fog and rain set in, obscuring their view of the enemy entry point.	• Send fire team to an Observation Post (OP) position • Stay in place • Move entire squad to get better view of enemy entry point
3	Mortars drop	Mortars drop across the road from the squad.	• Stay in place • Move the squad

| 4 | Ambush target arrives | The target enemy force makes its way up the road. | • Engage the following troop carriers first
• Engage the lead vehicle first |
| 5 | Squad sized enemy at extract | After all enemies are neutralized, the squad gets a notice to extract from their insertion point. An enemy squad is waiting for them. | • Set up a base of fire and maneuver around the enemy
• Direct all fire to enemy squad
• Break contact and egress |

4.4 SLTP 4 - Neo-Facist Rising of Odessia

A Neo-Nazi terror organization known as the Neo-Fascist Rising (NFR) has taken up arms against the local government of Odessia. They have been seizing key government infrastructure and eliminating "sluggish" citizens that they deem are a burden to society. The democratic government of Odessia has asked for outside assistance. Given their current location near Istanbul and the mass killings of Americans, the 24th Marine Expeditionary Unit has been ordered to prepare for a joint operation with the Odessia military to seize back key terrain and infrastructure from the NFR.

4.4.1 - Conduct a Reconnaissance Patrol

This scenario will require the squad to conduct a reconnaissance patrol of an old church that could serve as a combat outpost for 1st Platoon. This mission will require the Squad Leader to recall Commanders critical information requirements (CCIRs) to aid in decision-making when faced with unexpected events. This scenario addresses the following T&R Objectives: 0300-PAT-1009 and INF-MAN-4301. Table 21 displays the events contained in the Conduct a Reconnaissance Patrol scenario.

Table 21. Conduct a Reconnaissance Patrol Events

Event	Event Title	Stimuli	Decision Alternatives
1	Distant explosions	Explosions are heard in the distance at the beginning of the recon patrol	• Continue pushing, update higher • Ignore explosions, continue pushing • Explore the explosion source
2	Celebratory gunfire	Erratic gunfire is heard in the distance	• Continue pushing, update higher • Send a fire team to investigate • Move entire squad to investigate
3	Technical at road crossing	A technical vehicle comes down a road the squad is about to cross	• Hide, do not engage • Engage vehicle
4	Technicals open fire on squad	After crossing the road, multiple technicals open fire on the squad from the road	• Suppress and break contact to withdraw to objective • Dig in, return fire, and neutralize vehicles • Call for support from an adjacent unit
5	Enemy fighters engage squad	The squad takes gunfire from enemies after securing the compound	• Suppress and envelop to secure the compound • Engage the enemy from one location to secure the compound • Suppress and break contact to move towards extraction

4.4.2 - Secure a Bridge

This scenario will have the squad attempting to secure a bridge to prevent enemy movements. The Squad Leader will have to make various decisions in how to respond to enemy activity and how to prioritize enemy combatants. This scenario addresses the following T&R Objective: INF-MAN-4302. Table 22 displays the events contained in Secure a Bridge scenario.

Table 22. Secure a Bridge Events

Event	Event Title	Stimuli	Decision Alternatives
1	Civilians fleeing	3-4 civilians are seen running towards the squad from about 200-300 meters away.	• Question civilians • Do not engage • Engage
2	Civilian execution	An enemy lines up a few civilians with a gun pointed towards them.	• Detain enemies • Squad to shoot enemy • Disregard, continue on mission
3	NFR Boat Sighting	An enemy boat comes up the river towards the bridge and turns around to go back upstream.	• Observe and report enemy activity • Ignore boat • Engage the boat
4	MG fire & fire team while squad on the bridge	An enemy machine gunner & fire team opens fire on the squad as they near the bridge.	• Suppress and use precision fire to eliminate the threat • Obscure with smoke • Bound to break contact
5	5 Ton and BTR (armored personnel carrier)	Once the machine gunner is dead, the squad encounters a 5 ton full of troops and a BTR approaching the bridge	• Suppress enemy infantry & destroy armor with anti-armor weapons • Ignore infantry until armor is neutralized • Prioritize enemy infantry as target

4.4.3 - Destroy a Weapons Cache

This scenario will have the squad searching a house for an enemy weapons cache. The Squad Leader will have to determine how to proceed when the weapons cannot be found and enemy contact is made. This scenario addresses the following T&R Objective: INF-MGUN-4213. Table 23 displays the events contained in the Destroy a Weapons Cache scenario.

Table 23. Destroy a Weapons Cache Events

Event	Event Title	Stimuli	Decision Alternatives
1	Scooter leaves dry hole	A scooter leaves a house fitting target description	• Let the vehicle go and observe what happens • Kill the driver
2	Dry hole	The closest house fitting the target description is empty	• Expand search to buildings with similar descriptions • Search all nearby buildings • Call higher
3	Two men fleeing house	Two unarmed men in enemy garb flee another house fitting the target description	• Do not shoot the men • Shoot the men
4	Booby trap in house	Barrels of explosives; notification of bomb in the house	• Get full cover behind an obstacle (i.e. log pile, barn, truck) • Run away from house without seeking cover • Do nothing or attempt to diffuse bomb
5	Mortar & ambush attack	Mortar rounds and heavy machine gun fire	• Regroup, set up defense outside of mortar kill zone. Use base of fire and maneuver element against threat. • Regroup, order squad to pull back to a hasty defense and engage targets as they appear. • Set up hasty defense in the kill zone.

4.4.4 - Conduct a Ground Attack

The squad is charged with operating as part of a Battalion ground attack. The squad's mission is to overtake an observation post without alerting an enemy and support Alpha Company's assault on an objective. Though the squad is not forewarned, if the squad opens fire on Alpha Company's objective before Alpha Company begins their assault, the squad will get into a battle in which the odds are not in their favor. This scenario addresses the following T&R Objectives: 0311-OFF-2002 and INF-MAN-4001. Table 24 displays the events contained in the Conduct a Ground Attack scenario.

Table 24. Conduct a Ground Attack Events

Event	Event Title	Stimuli	Decision Alternatives
1	Vehicle breakdown	The squad's vehicles break down in route to the dismount location	• Begin movement on foot & then report to higher • Troubleshoot vehicle • Call higher for guidance
2	Secure the OP	The squad observes fire, smoke, and dogs as they move toward the OP	• Skirt rocks downwind to capture camp • Approach OP from any other direction than SW
3	Mortar positions at enemy objective	The enemies have mortars pointed in the direction of Alpha Company	• Call for fire on mortar positions • Directly engage mortar positions • Ignore mortar positions
4	Friendly Fire from Light Armored Vehicles (LAVs)	The squad receives friendly fire from Alpha Company LAVs	• Radio to higher & request cease fire • Take cover and wait it out • Engage the LAVs
5	Enemy Retreats from Objective 1	The enemy begins to retreat south away from Objective 1	• Hold in the OP & deny enemy egress to the south • Hold in place & engage targets of opportunity • Assault objective 1 on foot

5.0 STAR-DM Assessment and Debrief Tool

Assessment of DM skills in real-time during an exercise can be quite challenging for a few reasons, including that 1) decisions are sometimes made very quickly and are therefore easy to miss, and 2) much of the reasoning behind decisions happens in the mind of the decision-maker and is often forgotten by the time the scenario is over, meaning that assessment can generally only be based on the action taken and outcome of the decision. This also makes it more difficult to provide meaningful process-level feedback, as the first 3 steps in the OODA model of decision-making are lost. The use of turnkey simulation-based scenarios with specific decision events provides the opportunity to clearly lay out for the instructor (or whoever is conducting the assessment) what the decision events are and what aspects of the scenario may contribute to the OODA process. This provides a reference point from which to conduct the assessment and facilitate the feedback during the AAR. In the SLTPs, this opportunity led to the development of the Assessment and Debrief Tool, a tool to make the DM and learning strategies more accessible and easy to implement. The tool has evolved from a paper-based checklist into a mobile tablet-based software program that interfaces with VBS2 to pull additional performance metrics.

5.1 Paper-based Checklist

The checklist is arranged in such a way that the instructor can easily collect and scan information about the Squad Leader's DM process, and use the form to facilitate a process-level debrief regarding the

strengths and weaknesses of the Squad Leader's decision-making. The paper-based assessment checklist was used in the field study by Marine instructors and refined based on their feedback. The strong upside to this version is that it requires no extra technology to implement. The downside is that the instructor is either tasked with or unable to keep track of minute simulation details such as the event number or the number of times the squad is hit by enemy fire.

Figure 32 provides an example of the checklist for one decision event in Scenario 2 of SLTP 1. The checklist for each decision event includes five rows that correspond to the Observe, Orient, Decide, Act, and Outcome aspects of the decision. As the instructor observes the Squad Leader communicating with the squad during the scenario, he can listen for each of the items in the checklist to determine if the Squad Leader detects the important cues in the environment (Observe), recognizes the implications of the cues (Orient), considers various courses of action (Decide), and takes the appropriate action (Act). The instructor can check off each of these during the decision event, and then observe the outcome of the action that is taken and record that as well. The options listed in the checklist were developed by working with instructors from the ISULC to try to anticipate the most relevant options that may occur for Squad Leaders with a variety of experience. Therefore, some options are better than others. There is also an "Other" option in case something else comes up during a scenario that is not covered in the checklist. Additionally, there is a "Notes" section for the instructor to quickly jot down thoughts he would like to revisit for that decision event during the AAR.

Figure 32. Example of Decision Event Portion of the Paper-based Checklist

In addition to the checklist for each decision event in a scenario, the paper-based checklist ends with some metrics for the Squad Leader's performance in the overall mission (scenario). These items measure observation skills, situational assessment, adaptability, and effectiveness. Each item in this portion is rated essentially from 1-10 according to the categories shown in Figure 33 (Unsatisfactory-Outstanding). The final portion of the paper-based checklist, shown in Figure 34, allows the instructor to rate the difficulty of the mission to potentially provide some perspective on his assessment of the Squad Leader (e.g., if the Squad Leader did poorly but it was a difficult mission, the poor performance may not be as concerning as poor performance on an easy mission). The final portion also provides a place for the instructor to jot down any additional notes about the overall mission for him to revisit during the AAR.

Mission Outcome

Observation Skills – Overall ability to report the cues needed to formulate a decision:

Unsatisfactory		Below Average		Average		Above Average		Outstanding	

Situational Assessment – (METT-T analysis, EMLCOA, SOM FSP, Task &ME, Commanders Intent)

Unsatisfactory		Below Average		Average		Above Average		Outstanding	

Adaptive Decision Making- Ability to adapt to changes in terms of enemy action, friendly situation, and environment.

Unsatisfactory		Below Average		Average		Above Average		Outstanding	

Effectiveness – Overall all ability to manage and employ subunits and resources to achieve commander's intent

Unsatisfactory		Below Average		Average		Above Average		Outstanding	

Figure 33. Mission Outcome Metrics

Mission Difficulty

Mission Difficulty – Overall difficulty of the mission

Very Easy		Easy		Average		Difficult		Very Difficult	

Notes:

Figure 34. Mission Difficulty Rating and Mission Notes

5.2 Software-based Assessment and Debrief Tool

The second version of the assessment checklist is a Windows-based software tool that can be run on either a PC or a Windows tablet. It contains the decision event checklists for every scenario in SLTPs 1-4, is connected with the VBS2 simulation to monitor simulation details such as the event number and a variety of performance-based metrics, and has a checklist editor so that the instructor can make edits or create new checklist assessments. The software version of the Assessment and Debrief Tool (ADT) is designed to allow the instructor to quickly assess the Squad Leader's DM process and reference simulation metrics when appropriate to facilitate the Squad Leader's training. It has the added benefits over the paper-based checklist of 1) being able to rate the competence of the decisions at the process-level for each event in addition to checking off items on the checklist, 2) allowing the instructor to review the VBS2 metrics in real-time to help provide context during sometimes rapidly unfolding scenarios, and 3) providing an automatic AAR screen for the instructor that quickly summarizes his ratings to facilitate an immediate and thorough debrief. The software version does, however, require an additional computer or tablet.

As shown in Figure 35 below, the home screen for STAR-DM ADT is where you can access all of the different options the program offers. There are five different pages to choose from: Assessments, Load

AAR (After Action Review), Assessment Builder, Help, and Log Out. Assessments monitors live scenarios and has input for evaluation tracking. Load AAR allows the instructor to reassess existing AARs at any time. Assessment Builder allows you to create a new scenario. Help provides a document with essential information. Log Out returns you to the Log In screen.
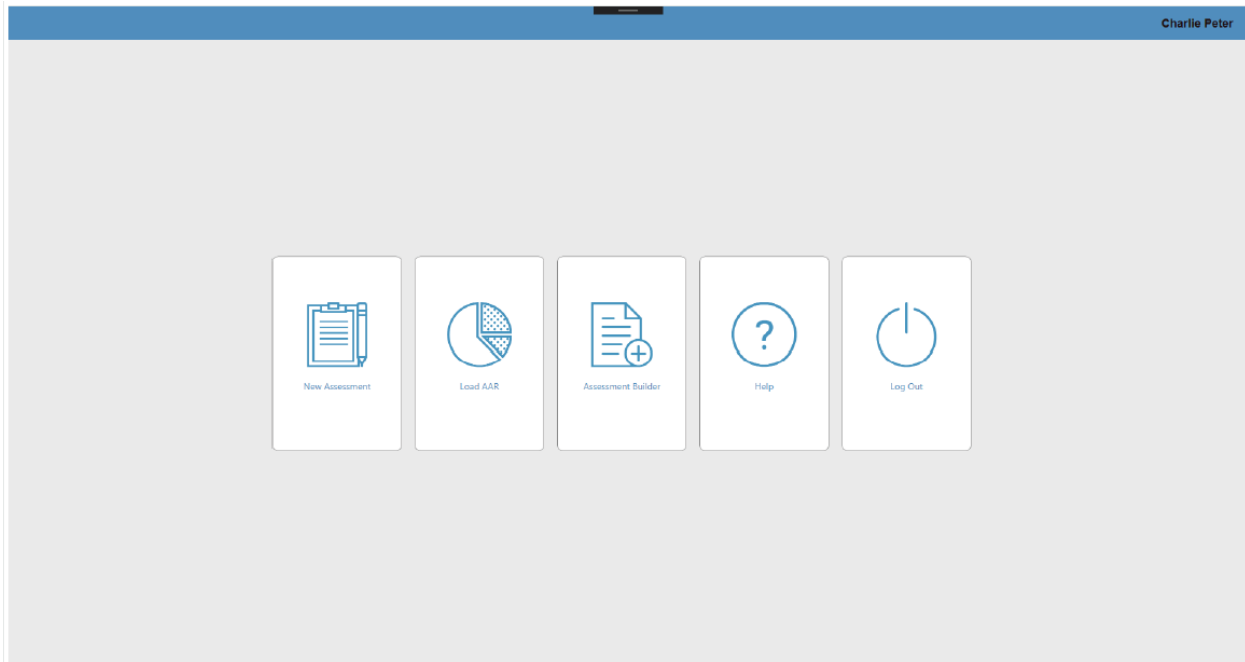

Figure 35. ADT Home Screen

Assessments
Assessments in STAR-DM ADT allow the instructor to follow and review a student's performance in real time. These assessments allow the instructor to view live scenario events, to take notes (typed and hand written), and to rate the student's task execution. The Assessment page (Figure 36) is separated into three main sections – Current Scenario, Scenario Events, and Events. The current scenario is what determines the content that will be shown for the events. This is the first choice to make when arriving to the Assessments page. The scenario will begin once the student has started their session on the Trainee Squad Leader Computer. In the Scenario Events section, a "Scenario Start" timestamp will appear once the scenario has begun. The Scenario Events section (top of the screen in Figure 36) holds the real-time information. Events will be written out per line, with a timestamp and information about what happened at that time. These are helpful for reviewing exact times for events for ratings. The timestamps will indicate when a scenario and event has begun or ended. Events in a scenario are categorized according to time and action. Each scenario has five events. To change an event, the user selects the event button and the corresponding table will appear. An Event table has four columns: steps, actions taken, notes, and overall rating. Within actions, the checklists allow the instructor to correspond student activities with completion. Notes are helpful for leaving extra information. Note buttons are available for each Event and also have the ability to leave handwritten notes. Overall ratings for each step can be assigned with four different ratings: Good, OK, Poor, or Not Sure.

Figure 36. Assessment Screen

After Action Review

AARs are a debrief process for analyzing what happened and why it happened. STAR-DM ADT's AAR provides the instructor with a summary and details of trainee performance for each scenario. Instructors can view their notes, ratings, and statistics gathered from the scenario. The AAR also allows saving and loading, a useful tool to review summaries when needed. On the home page, a Load AAR button allows the instructor to reassess existing AARs at any time. Within an Assessment, the AAR button within the Assessment menu (located in the top blue bar) will automatically open the AAR related to the current Assessment. The AAR is laid out in three different sections: Scenario Summary, Event Results, and Assessment Notes, see Figure 37. The scenario summary shows the comprehensive numbers for the entire scenario. The metrics are listed downwards on the left, and the corresponding results are on the right. The event results is comprised of two separate sections – Checklist Results and Metric Results. Both of these sections review the individual outcomes and metrics for each event. The checklist results review the instructor-determined overall ratings for the steps within each event. The green checkmark is Good, the yellow warning is OK, and lastly, the red X is Poor. The metrics results for the event results are similar to the scenario summary, but are detailed for each individual event. This elaborates on the scenario summary and provides further detail. The assessment notes section provides a scrollable window to review instructor-taken notes from the assessment. The notes are structured linearly, from the first event to the last. Also, the instructor can load written notes. Saving an AAR enables the AAR to become available for review in the future.
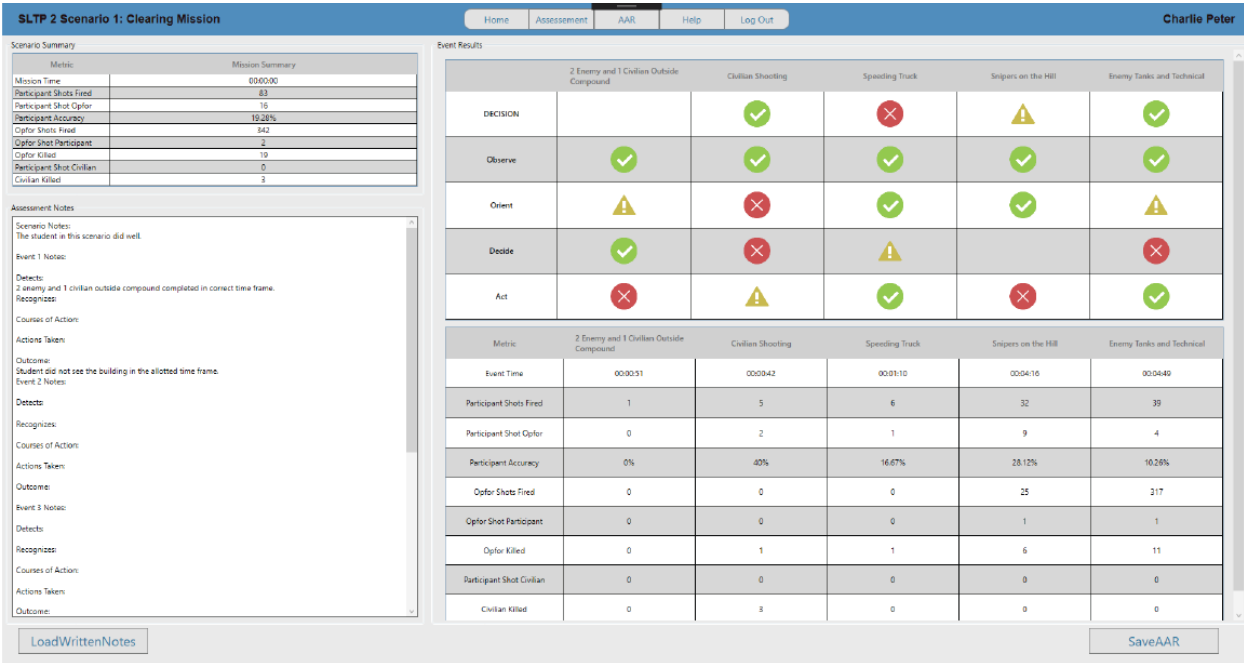
Figure 37. AAR Screen

Assessment Builder

The Assessment Builder (Figure 38) gives the instructor an opportunity to author scenario assessments. It allows the instructor to input details for five events. The only constraints applied to the scenario builder are those that are based on the SLTP training framework. 1) Each scenario must contain five events. The events are listed in chronological order and are helpful for creating student action checklists. 2) All events must have at least one item for each category: Detects, Recognizes, Courses of Action, Actions Taken, and Outcome.
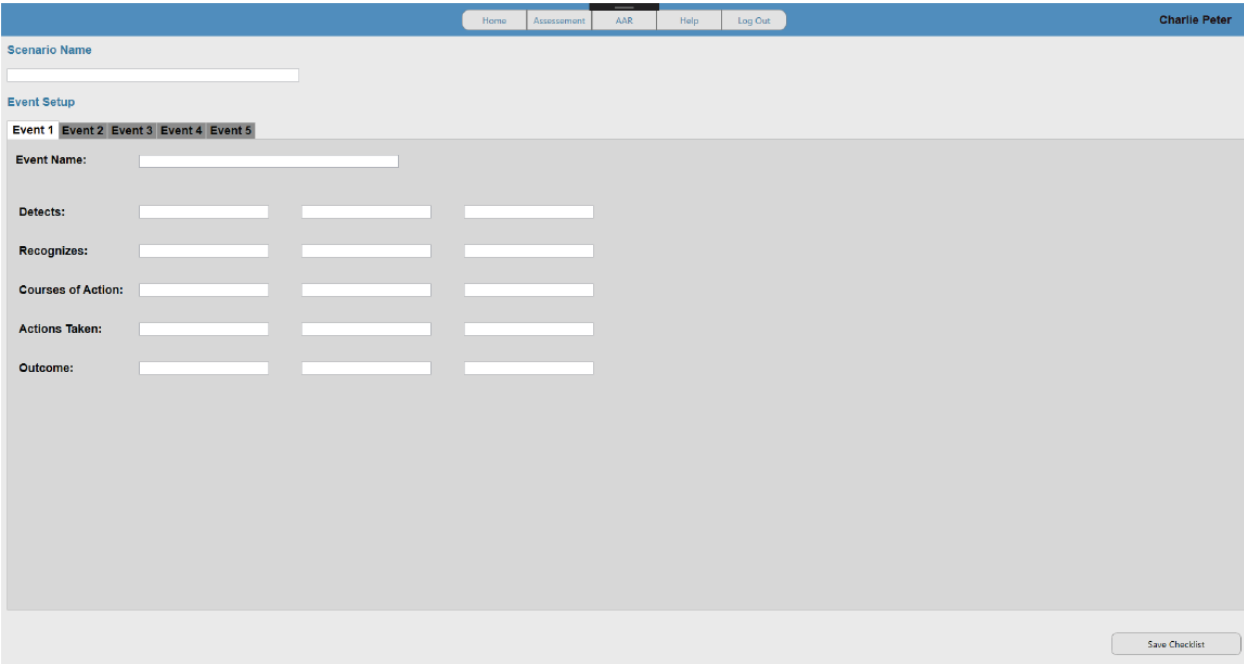
Figure 38. Assessment Builder

6.0 Transition and Way Forward

A formal Technology Transition Agreement (TTA) has been created for STAR-DM and iterated with transition partners. It has not yet, however, been approved. One potential issue that has come up is that the SLTPs were developed in VBS version 2.15 and subsequent to their development, the Marines have upgraded many of their computers to VBS3. There are some backwards-compatibility issues with VBS3 which would require updates to the SLTPs in order for them to fully function in the new version. Therefore, it is recommended that the SLTPs be upgraded to the current VBS version in order for them to be readily used. However, the SLTPs have still been transitioned to a few locations. Both Camp Upshur and the IIMEF Simulation Center were involved in a SLTP evaluation event and received copies of the SLTPs and all supporting material. Additionally, the Combating Terrorism Technical Support Office and the Camp Pendleton IIT have received copies of the SLTP training packages as well.

In terms of future research, there is still a desire to conduct the planned TEE to fully evaluate the training effectiveness of the complete STAR-DM training framework as well as to determine the return on training investment for the multiple training environments of interest. It is recommended that the program sponsors continue to pursue available participants for the execution of such a study in a follow-on effort.

Furthermore, the addition of a simple socio-evaluative stressor prior to simulation-based performance led to significant increases in physiological stress response. Stress response was effectively captured via electrodermal and cardiovascular measures of heart rate and skin conductance level. Further, an algorithm which assesses changes in heart rate and skin conductance level to quantify/qualify an individual's short term resilience to stress was developed and revealed the ratio of baseline perceived stress to baseline cortisol levels are potentially effective predictors of an individual's resilience to stress. Further research is needed to explore the effectiveness of such methods at predicting resilience. Continuing work is focused on adapting this training to military personnel, and assessing the utility of various coping and decision-making strategies on performance and physiological stress.

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Appendix A. Key Terms

AAR	After Action Review
AITB	Advanced Infantry Training Battalion
AO	Area of Operation
AOI	Area of Interest
BARS	Behaviorally Anchored Rating Scale
BFT	Bio Feedback Training
CASE	Collect data, Assess situation, Select response, Evaluate response
CD-RISC	Connor-Davidson Resilience Scale
COA	Course of Action
COC	Command Operations Center
CTTSO	Combating Terrorism Technical Support Office
DM	Decision Making
DMAT	Decision Making Assessment Tool
ECG	Electrocardiogram
EDA	Electrodermal activity
EDR	Electrodermal Response
EMG	Electromyogram
FINEX	Finish of Exercise
FRAGOs	Fragmentary Orders
HRV	Heart Rate Variability
IIT	Infantry Immersion Trainer
IPG	Instructor Preparation Guide
IRR	Interrater Reliability
ISULC	Infantry Small Unit Leader Course
MAGTF	Marine Air-Ground Task Force
METT-TC	Mission, Enemy, Terrain & Weather, Troops, Time Available, and Civilian Considerations
MSEL	Master Scenario Event List
OODA	Observe, Orient, Decide, Act
PPG	Pulse Plethysmography
PTT	Pulse Transit Time
ROTI	Return on Training Investment
RSA	Respiratory Sinus Arrhythmia
S&T	Science and Technology
SECPT	Socially-Evaluated Cold Pressor Test
SET	Stress Exposure Training
SHOR	Stimulus, Hypothesis, Options, Response
SJT	Situational Judgment Tests
SLTP	Squad Leader Training Package
SME	Subject Matter Expert
SOI-E	School of Infantry - East
STAR-DM	Small-unit Training for Adaptability and Resilience in Decision Making
STEX	Sand Table Exercise
STO	Science and Technology Objective
STOPS	Strategic Operations
T&E	Training and Education
T&R	Training and Readiness
TDG	Tactical Decision Game
TEE	Training Effectiveness Evaluation
TSST	Trier Social Stress Test
TTPs	Tactics, Techniques and Procedures
USMC	United States Marine Corps

Appendix B. Decisions Library

Situation	Task/ Mission Objective	Decision	Prerequisite Knowledge Affecting	Data to Collect / Cues to Observe (METT-T Analysis)	Orient/ Situation Assessment (what does this mean)	Decide/ Potential COAs (Pros/Cons) (Decision Alternatives)	Which Action did you take? Why?	Outcome(s)	What factors made it stressful (environmental factors vs. task factors)
Marine in squad lost control of a weapon that was firing wildly; weapons malfunction		Decision was made to physically remove Marine from behind the weapon so others could gain control		Ldr observed gun barrel pointed at Marines; observed Marine at gun in awkward body position; observed Marine at gun white knuckling the weapon unable to control it	Realized the weapon was out of control and all of the Marines in the vicinity were in danger	Get shot; Hit the deck without concern for others	Physically removed the Marine from behind the gun	Safely took control of the weapon without injuring other Marines except the one that needed to be physically removed	emotional connection to squad; large barrel pointed at you from close range; unanticipated situation
Former Marine working as Contractor providing Executive protection in Mexico for CEO's, VIPs, etc..	Transport HVI between locations	Which route to take		Knowledge of the danger of the area; tactics used by Cartels; ability to use children as intel agents	Built positive relationships with children in the area; Child ran up to convoy and alerted them to violence that was about to take place on a particular route.	Contractor - trusting child realized this could put the convoy and HVI in jeopardy	ACOAs include proceed on planned route; take detour to avoid possible violence.	Chose to take detour to ensure the safety of the HVI.	Convoy continued without incident. There was escalating violence on the original route

Doing training op with Thai, so gun trucks and LAR, in support by fire/ overwatch, got dusty/cloudy and no one could see where friendlies were	Fire on objective	Should he fire?	friendlies would be maneuvering on the objective	dusty/cloudy from LARs	he could not see the objective well and couldn't see friendlies - so he might hit them	Shoot without visibility, coordinate to try to increase visibility - he talked to LAR and asked them to slow rate of fire to get eyes on objective; got maneuver elements on comm to find out if they were in place		increased visibility on objective and knowledge of location of friendlies	dusty/cloudy with friendlies coming in; stressful knowing another countries' guys were attached - not sure what they would do
	Deconflict other elements attached and trying to maneuver on an objective		knows where friendlies are located	objective	objective is clear - so he can fire weapon without endangering friendlies	Fired the missile; could have chosen different weapon system if friendlies were within danger area; could have cut off fires	Firing missile was best decision - was mission, and correct measures had been taken to deconflict	mission was successful	

Engaging targets outside of max effective range of Javelin system, did not have clear field of view - knew that there were enemies but also children, being actively engaged at the time; did not know if officer knew that there were civilians		children may be in vicinity of target	Shoot or just wait until weapon is ineffective	not clear field of view, knew that there were children; did not know if higher who gave the go-ahead to shoot knew that there were children; snipers next to him that could take out the enemies	might hit children	Waited for weapon to expire; could have shot		enemies were taken out by other means	Time pressure - 4 min for weapon to be fired before ineffective; possible women and children that could be hit; limited visibility
While a team leader, on a hilltop looking over a small village, like guardian angels for dismounted and mounted patrols, watched area for 6-8 hours a day for a few days while patrols would travel through. On 3rd day, at an intersection saw a farmer start digging next to intersection a couple of hours before patrol would travel through. Farmer started emplacing in ground. Superior told not to engage the farmer.			Killed farmer despite being told not to by superior	farmer at intersection digging a hole and putting something in it	farmer probably placing IED and would probably place other IEDs in the future	decided to shoot		farmer was killed	Higher would not allow to fire even though everyone on the team saw the IED emplaced

Mobile assault platoon - truck got blown up by IEDs and lost comms and needed to comm with trucks behind	communicate with trucks through hand signals							
Outside a patrol base and one squad's comm went down and then went back to base, they walked into an ambush, hit on 2 sides		what to do when other squad being shot and superiors trying to tell people what to do when he was patrol leader		heard shots	other squad taking fire	had LT call in indirect fire to take out enemies shooting at squad		squad got out ok	time pressure; friendlies under fire; superiors on patrol with squad were trying to tell people to do things that did not mesh with Squad Leader's plan; was first time in combat for one superior

truck behind him got blown up - gunner saw a guy standing		whether to tell the gunner to shoot	usually if first truck in a convoy does not blow up, it means that there is a trigger man; in that AO, trigger man usually runs away after setting off trigger	man standing near where the IED went off	man is probably not the trigger man for the IED	detained the man instead of shooting him		when man was detained, turns out he was not the triggerman (it was a pressure plate IED), but he was Taliban	
Battalion set up in blocking position for CAT section conducting rescue mission for downed helo. He was machinegun team leader at the time. At intersection, squad of Marines at each corner, car came speeding toward intersection, Marines told it to stop, fired warning	Provide security for QRF that was assisting a downed helo	Shoot at guys in the speeding car or don't shoot	Vehicle not reacting to escalation of force measures (e.g. warning shots fired) may be a threat	vehicle coming very fast, Marines trying to get car to stop through escalation of force (telling them to stop, firing warning shots), vehicle passed trigger line	car might be a VBIED	had gunners engage vehicle; another decision - don't have gunners engage vehicle	had gunners engage	Stopped car through force, found 3 military aged males with weapons and grenades in car.	concerned about welfare of whole platoon; tired and hot; civilians in city could be harmed

Set up in blocking position on back side of cemetery on outskirts of city, set up in L-shape blocking position, makeshift control measures set up. A dump truck came up and wasn't trying to plow through, but did cross control measures	Prevent weapons and key leader movement on outskirts of city	shoot truck driver or don't shoot	water trucks had been used as VBIEDs, but truck driver did not meet the criteria for seeming like a threat	truck driver was old, by himself, was not moving really fast, in outskirts of city, stopped when a warning shot was fired	probably not a threat	did not shoot; could have shot him	did not shoot	guy was just lost and old and did not realize where he was; Marines helped him get c-wire out of the tires and point him in the right direction	very fatigued; hot outside; being shot at from an exclusion zone that Marines could not fire back - morale down; battalion let them down - went 2 days without water
Plt Sgt in charge of 28 Marines - protective detail for many important people. Coming down unknown route w/o any important people at the time, with no problems. In first vic - Come up on flat open area, right side of truck sink into earth - very fine sand and water. At one point 4 of 5 vehicles stuck in mud. Had to get out and dig vehicles out - took about 5 hours	Transport and protect HVI between 2 locations	Dig vehicles out themselves or wait for help	Knew they were out in the open in a bad part of town	multiple vehicles sank slightly into ground	they needed to get the group out asap	decided to dig out vehicles; another decision - wait for recovery team to come out and help		it took 5 hours to dig all vehicles out, but everyone made it out safely	Environment - out in open in dangerous neighborhood, being yelled at about timeline from Lt Col even though mission had priority

At govt center and there was large protest, had a bunch of state dept civilians, had to get them from downtown to the Camp. People started to throw rocks at state dept people.	Protect and transport state dept civilians to get them back to the FOB	How to disperse the crowd	a few blocks away from high profile instances of extreme violence	People in crowd were getting increasingly hostile - began throwing rocks	might try to hurt the state dept civilians - need to get them out, need crowd to disperse	Shot fires into the ground		got everyone out safely without hurting anyone	being outnumbered; not being able to trust local populace, even Iraqi police; being inside the Iraqi govt center; knowing what crowd was capable of
Told another unit that it was alright to fire weapons over the heads of his squad. Effects were very short and ended up hitting many Marines in his squad, had to suddenly deal with mass casualties (8-9 Marines down)	CASEVAC mass casualties and keep rest of squad safe	How to get Marines CASEVAC asap	Saying squad is in danger may get air assets to support quicker than CASEVAC	many Marines were badly hurt	need to get a lot of help very quickly	Said that he was in danger instead of calling for CASEVAC to get air assets to him faster		got everyone out	having so many casualties on his team; low on ammo
Had less than a full squad after taking casualties - had 2 fire teams and they were taking mortars fire from an enemy unit larger than them		initiate fire or break contact	accuracy of mortars not great - knew effective distance of enemy mortars	distance between enemy and Marines	Marines were within effective distance of mortars	moved Marines back and fought back		Marines stood their ground	Marines were upset about the casualties they took; low on ammo